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[OFFICIAL NOTICE.]

Fifth Annual Meeting, Pacific Coast Gas Association.

PACIFIC COAST GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
OAKLAND, CAL., June 4th, 1897.

The fifth annual meeting of the Pacific Coast Gas Association will be held at San Francisco, Tuesday and Wednesday, July 20th and 21st, 1897, at 10 o'clock, A.M., in the office building of the San Francisco Gas and Electric Company.

A meeting of the Board of Directors will be held on Monday, July 19th, at 8 P.M., at headquarters in same building.

The following papers will be read and discussed during the sessions:

The President's Address, by Mr. T. R. Parker, Napa, Cal.

"Spontaneous Ignition of Coal," by Mr. John L. Howard, San Francisco.

"Reminiscences," by Mr. F. H. Eichbaum, San Francisco.

"Value of Small Gas Bills," by Mr. W. W. Gillespie, San Francisco.

"From Coal Gas to Natural Gas," by Mr. John Kempf, Jr., Salt Lake City, Utah.

"Small Lighting Plants and their Management," by Mr. Thos. D. Petch, Eureka, Cal.

"Practical Suggestions," by Mr. Chas. E. Burrows, Walla Walla, Wash.

"Uniformity of Accounts," by Mr. C. O. G. Miller, San Francisco.

"Municipal Control," by Mr. C. W. Quilty, San Jose.

"A Short History of a Long Life," by Mr. C. M. Converse, San Francisco.

"Recuperative Benches for Coke and Coal Firing," by Mr. D. R. Russell, St. Louis, Mo.

"Card Bookkeeping," by Mr. V. Stow, San Francisco.

"Gas as Fuel," by Mr. F. Foveaux, San Francisco.

Questions received will be assigned to members for reply.

The "Experience" Department, edited by Mr. John Clement, of Red Bluff, Cal., and the "Wrinkle" Department, edited by Mr. M. C. Osborn, of San Diego, Cal., will make report.

All gas men sojourning in San Francisco at the time of the meeting are cordially invited to be present and to participate in discussions. The Secretary will at all times cheerfully answer any questions and furnish information concerning the meeting, hotel accommodations, etc.

Thursday, July 22d, 1897, will be the outing day for members, their families and friends. A trip on the world-famed scenic railway to the top of Mount Tamalpais will be made, and luncheon served at the "Tavern of Tamalpais." From San Francisco to the mountain top there is revealed the grandest panorama of ocean, cities, towns, bays, valleys and mountains in the world, the view reaching from the snow-capped Sierras to 60 miles from the Marin county shores on the Pacific. The usual banquet will be held on Tuesday evening, July 20th.

Eastern members, and others from the Eastern States intending to visit San Francisco, are requested to advise the Secretary in advance.

JOHN A. BRITTON, Secretary.

BRIEFLY TOLD.

A QUEER STORY FROM CHICAGO.—Many queer stories have been composed in Chicago, but that is not to be wondered at, for the emotional temperament is often displayed by the residents of that surprisingly rapid city. Emotionalism, however, is not a very safe guide, especially when business affairs of magnitude are under consideration, so we may be forgiven for saying that, had the Chicago story tellers cultivated patience in thought rather than surrendered to the convulsiveness of hysterical expression, their recitals of things to come would be couched in words defining the truth of what was done when the things spoken of "had come to pass." The instance that prompts this comment was afforded by the Chicago *Tribune*, in its issue for the 12th inst., which, referring to the proposed legitimate and final consolidation of the gas interests of Chicago, hysterically declares, "The price of gas in Chicago is to go up"—but the *Tribune* fails to state how high it is to "go up," although the next line declares, "This is official." The capitalists in control of the Companies that originally entered into the first combination, familiarly known as the Chicago Gas Trust, are now planning the scheme under which the legal amalgamation of their joint properties is to be completed, and it is but natural that, out of the several charters (seven is the number, we believe) possessed by them, they should select the one best suited for their purpose. It is generally believed that the instrument that will be used for the basis of the amalgamation is the charter of the Peoples Gas Light and Coke Company, which, although unassailably rigid in its legality and bindingness, is quite flexible in other directions. The charter contains a provision which declares, under the pledge of the State, that "The Common Council of the City of Chicago may, by resolution or ordinance, regulate the price charged by said Company for gas, but said Common Council of the City of Chicago shall in no case be authorized to compel the said Company to furnish gas at a less rate than $3 per 1,000 feet." It is this provision that caused the *Tribune* to emit its "official" declaration that "the price of gas in Chicago is to go up;" but as the capitalists who are combining under the Peoples charter are not fools, we beg leave to say to the Chicago *Tribune* that any change in the present selling rate of gas in Chicago will be in line with "coming down" rather than with "going up." Messrs. Flower, Billings, Brady, Benedict and their associates are not given to hysterics, although each and all of them can be counted on to do the best they can for themselves. This admission further prompts the thought that in the final adjustment of the gas supply of Chicago they will have seen their way clear to an inclusion in the system of every gas company authorized to transact business in Cook county.

NOTES.—The July meeting of the Society of Gas Lighting was held in the buildings devoted to the noble charity known to the world officially as the New York Catholic Protectory, the President of the Board of Trustees of which is Mr. James R. Floyd, of this city. The Protectory grounds and buildings are located at Van Nest, Westchester county, a short distance out of the city on the line of the Suburban branch of the New York, New Haven and Hartford Railway, and the buildings, the maintenance thereof and the good that results from their beneficent use, are matters that can only be appreciated by those who have visited the place and reasoned over its workings. The Society visited the Protectory as the personal guests of Mr. Floyd, and that mention is sufficient to show that in every sense the host left nothing undone that he should have done, to the perfect interest and complete satisfaction of the visitors. A feature of the proceedings was an excellent dress parade and military drill by the Protectory Cadet Corps (numbering 350), the reviewing officer being Captain Wm. Henry White.——The papers announcing the incorporation of the South Omaha (Neb.) Gas Light Company state that its capital stock is $150,000, and that the incorporators are Messrs. Jas. Gilbert, Burton E. Wilcox, Daniel Cameron, Dwight L. Holmes and Isaac N. Knapp.——It is said that the Westinghouse Machine Company is constructing a 700-horse power gas engine, to be eventually installed in the power house of the Allegheny County (Pa.) Electric Light Company.——Important plant enlargements are contemplated by the proprietors of the Bridgeport (Conn.) Gas Company.——The Dover (N. J.) Electric Light Company has applied to the Dover City Council for an ordinance permitting it to manufacture and distribute gas.——The proprietors of the Lower Merion Gas Company, of Ardmore, Pa., have decided to increase the number of shares of capital stock, from 3,000 to 4,000, of the par value of $50 each.——The executive management of the St. Joseph (Mo.) Gas Company has notified the shareholders that a meeting of the St. Joseph Gas and Manufacturing Company will be held on the 4th prox., for the purpose of voting on a proposition to issue a mortgage, not exceeding $1,000,000.

[Prepared for the JOURNAL.]

Arithmetic and Chemistry Support Mr. Shelton's Contention in Respect of Fuel Gas.

By MR. J. P. GILL.

In looking over some late JOURNALS, which I have not had an opportunity to read with that attention which they merit, I re-read with much interest the able, as well as entertaining and satisfactory, paper of Mr. F. H. Shelton, on "The Failure of the Commercial Attempts to Supply Fuel Gas in the United States," read before the Western Gas Association and published in the JOURNAL of June 7th. The following statement is made therein: "Heat in gas form has not, as a whole, been sold any cheaper in the shape of fuel gas than already sold in the shape of illuminating gas; and, therefore, the public has been no better off."

In the subsequent discussion, one of the speakers observed that he could not see why a gas, though containing but 300 heat units, and sold at 30 cents per 1,000 cubic feet, should not be cheaper than gas from which there can be obtained 600 heat units, but which costs $1 per 1,000 cubic feet, even though double the quantity of the former is required to produce like results as the latter. This looks reasonable, for 60 cents is certainly much cheaper than $1. When doctors disagree, who shall decide?

It has occurred to me that the following considerations will solve the question in a satisfactory manner. It is known that the heat units have a certain proportion to the quantity of oxygen required by different substances for their combustion; this proportion being, of course, not a fixed one, but only approximate. For instance, 1 pound of hydrogen requires 8 pounds of oxygen for its combustion, producing 53,300 heat units, omitting the latent heat of the watery vapor. One pound of carbon requires $2\frac{2}{3}$ pounds of oxygen for its combustion, producing 14,400 heat units, the proportion between the oxygen and heat units being the same—viz., one-third. One pound of carbonic oxide (CO) requires .57 pounds of oxygen, producing 4,400 heat units. One pound of heavy carbureted hydrogen (H_4C_2) requires 3.43 pounds of oxygen, producing 20,940 heat units, both being less than one-half of the oxygen and heat units of hydrogen.

A water gas of 300 heat units will require about 63 pounds of oxygen for its combustion, and good coal gas about 110 pounds of oxygen, the proportion being 1 to 1.75; therefore (by way of contrast, or somewhat on the principle of the *reductio ad absurdum* of the geometricians, or that of *not* paying, say $10 for an article which will do good service 2 years, but paying $5 for an inferior one which will last only 6 months, the latter being twice as expensive as the former), the cost of 2,000 feet of the water gas will be $60 \times 1.75 = \$1.05$, as compared with $1 for the coal gas. This ratio is of course only relatively proportional, not absolutely.

Arithmetic in the form of the rule of three, shows that the speaker was right, and chemistry that the writer was right. The evidence is, therefore, in favor of the writer.

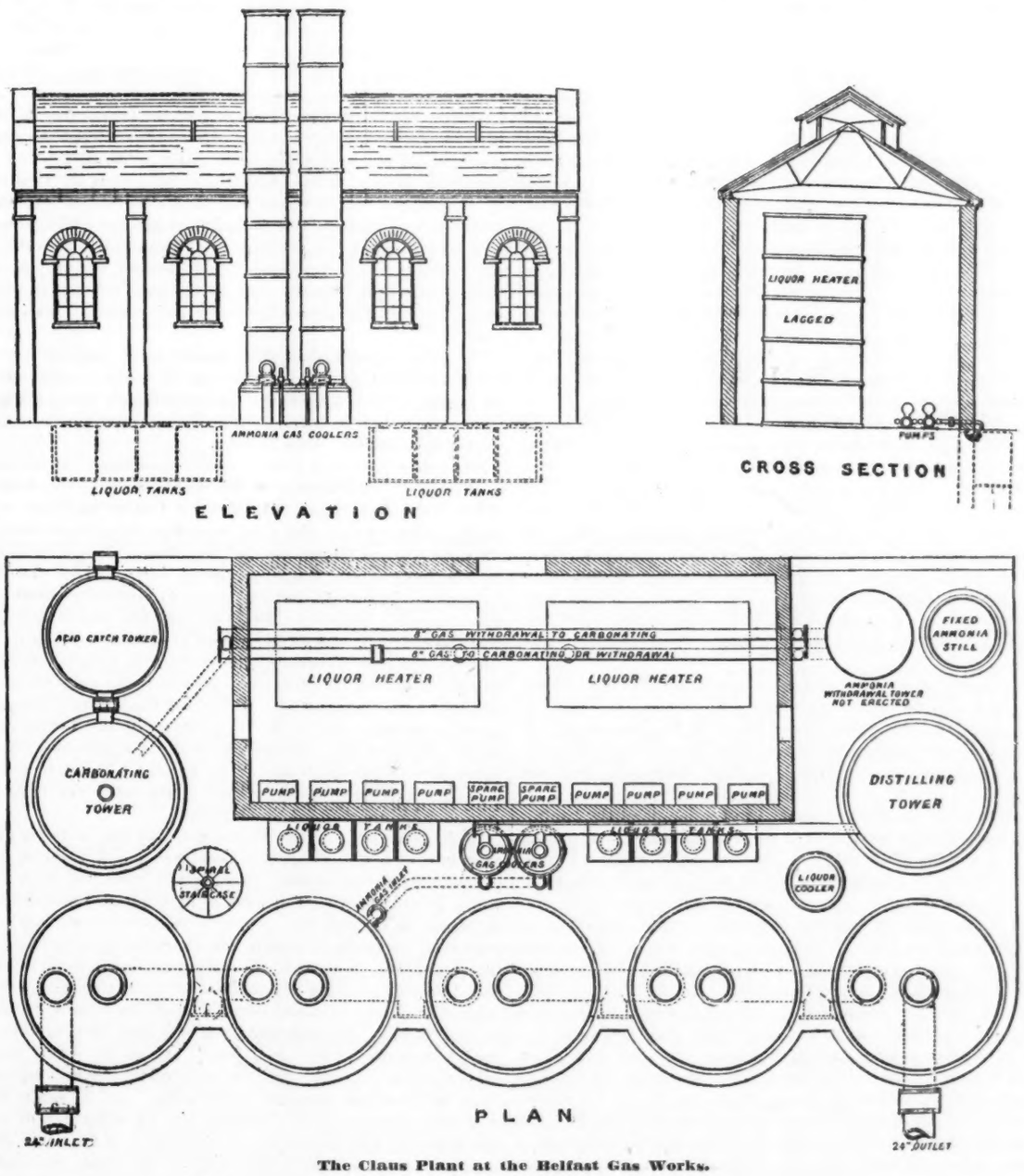
A further consideration is that any surplus quantity of air used in the combustion of the gas requiring the least oxygen will have a more injurious effect than the same extra quantity used in the combustion of the gas requiring the larger proportion of oxygen. As it is difficult in practice to admit the exact quantity of air required for combustion, the result will be that the richer gas will suffer less than the poorer, and consequently that a larger proportion of the latter will have to be used than of the former.

There might also be taken into consideration the principle that heat like light is accumulative; that is, they increase, under the proper condition, in a greater ratio than the quantity of gas consumed. But enough has been said to substantiate the opinion expressed by Mr. Shelton, as quoted at the commencement of this communication.

Experiments with the Claus System of Purification at Belfast, Ireland.

[A paper read by Mr. James Stelfox, of Belfast, at the 34th General Meeting of the Incorporated Gas Institute.]

In the latter part of the year 1885, we were in trouble. Paint had been blackened in the neighborhood of the gas works; and the general verdict of the public was that we did this "deed of darkness." Our frontage extended some 450 yards along the main thoroughfare, on the side opposite to the disfigured property; so that not only were we held responsible for all the emanations from our own works, but also for all that passed over us from adjoining chemical and other works. Vainly we pleaded that we had merely carried on the same operations as in



The Claus Plant at the Belfast Gas Works.

former years, when no cause of complaint had been found. We were convicted of the offence, and ordered to pay damages to our aggrieved neighbors. Considerable feeling was excited over the subject; and possibly a slight flavoring of politics was imported, which did not tend to smooth matters.

For some time prior to this incident, a strenuous effort has been made to introduce the coal liming process in several works; but the result had not been very encouraging to its promoters. Our trouble seemed to afford them a ray of hope; and no sooner had the news of our dis comfiture been made public, than one of the chief apostles of the system took up his residence in our midst, and spent some weeks of his valuable time in teaching the inhabitants in the district how to make sulphureted hydrogen traps. Of course, it was promised that the adoption of coal liming would be a perfect cure for the alleged nuisance; but the Gas Committee could not be induced to take it up, and the mission came to nothing.

The public feeling still, however, continued, though no further case of "blackening" was alleged; and the Committee, with my entire approval, placed the matter in the hands of an eminent expert, in order that he might report to them if anything could be done to improve the system of purification, which was blamed for all that had occurred. This step, however, only made matters worse, as the Committee were advised to attempt alterations of a wildly impossible character, which, if they could have been carried out at all, would have cost at least $400,000, and would not have answered any good purpose. In this trying state of affairs, I bethought me of a process which I had heard was being tried experimentally in Birmingham by Mr. Hunt; and I promptly decided to run across and see it for myself, and at same time learn all that was to be learned about it. Mr. Hunt received me with his usual courtesy; and under his guidance, I received my first lesson in the Claus system of purification. On my return, I at once devoted myself to a thorough investigation as to the possibility of working the system; and I found that, though I was unable to provide a site for the whole of the appliances on one side of our works, I could, by separating the purifying process from the sulphur recovery, make enough room. I also discovered that I could, by a very simple connection, arrange that the gas after leaving the Claus apparatus should pass on to our ordinary lime purifiers. This made us quite safe in case of any failure on the part of the new system, and paved the way for its adoption. Accordingly, in May, 1886, I ventured to advise my Committee to arrange for a plant which was to be calculated for the purification of 2½ millions per diem.

It will be seen that we were in a measure forced into a trial of this system, by the circumstances which I have already mentioned. It is, however, unquestionable that the Committee were greatly taken with the advantages seeming to accrue from its use, as well as with the promise of a large revenue which was to be derived from certain residual products. A deputation, accompanied by the Town Clerk and myself, proceeded to London to negotiate with the Ammonia Gas Purifying and Alkali Company, Limited, who had purchased the patents, for the right to use them. We formed the opinion that the Directors were a body of honorable business men, who fully believed in the practical value of their patents; and we have never had any reason to alter this view. An arrangement was effected, and everything settled except mere details. The Company not being manufacturers, nor giving us any guarantee further than the figures obtained in the experimental operations at Birmingham, we decided to prepare a specification in accordance with their ideas, and to ask for tenders for the work. It was determined not to have a patch-up plant. Accordingly everything was made new; and in respect of shape, capacity and details, the wishes of the Company and the patentee were fully carried into effect.

The contract was entrusted to Messrs. Samuel Cutler & Sons in the autumn of 1886, on the basis of sketch plans, accompanying the general specification for the work. Some vessels originally contemplated were, however, discarded, and the construction of others changed. The The elaborate system of pumps and connections had to be settled, and numberless details worked out; so that it was not until the close of 1888 that the plant was ready for work. The plans shown are those originally prepared; and in the main the work was carried out in accordance with them—the only exception being that the sulphur chambers were constructed in two stories, the end or single chamber being placed over the two smaller chambers, which were in direct communication with the two sets of kilns.

I shall not trouble you with any elaborate description of the process, which will, no doubt, be familiar to most of you through the paper of Mr. Charles Hunt, of Birmingham, contributed to the Institute in 1886. My intention is rather to give a brief account of its working than to discuss it from a technical point of view. A short description will not, however, be out of place.

The system proposes to effect complete purification of gas by combining the acid and alkaline impurities to form soluble salts, to be taken up by water in a series of scrubbers. This process is going on every day in gas works as far as the ammonia in the foul gas will carry it; but as the acid impurities are present in a much larger proportion than the alkaline, ammonia must be added in sufficient quantity to effect the necessary combination. This extra supply is to be derived from ammoniacal liquor; and the apparatus may be divided into two sections, in addition to that for the recovery of sulphur. In the first the liquor is treated; and the second consists of the vessels in which the gas is to be purified. In the former is included a heater, built up of flat sections, each of which contains a steam chamber, provided with steam from the main supply, which is regulated at will by means of a tap. The liquor, which is introduced at the top, is made to run in a tortuous course over the surface of each of these trays by means of baffles; and on reaching the opposite end of the tray from that at which it enters, it overflows on to the next plate, and so continues to the bottom of the vessel. The lower trays are kept at 195° to 200° F., at which temperature a large proportion of the carbonic acid and sulphureted hydrogen is driven off as gas, and passed on to the sulphur recovery plant. The remaining liquor is therefore principally caustic ammonia; and this is treated in a still, and the ammonia gas is taken, after cooling, to the purifying vessels, where it is mixed with the foul gas. The resultant salts being removed in the scrubbers, the gas is purified, and the strong liquor formed is returned to be again treated in the heater; so that, theoretically, there is no loss of ammonia. The gases driven off in the heater are passed through a scrubber and catch tower on their way to the sulphur recovery chambers, so that any ammonia passing away is arrested and returned to the system.

Early in the year 1887 the Ammonia Purification Company informed me that they had decided to give up work at their Birmingham plant, and urged me to engage their chemist and their two workmen, so that we might be able to start our new apparatus with trained assistants. Mr. Watts had devoted his great ability to the development of the system from the period of its inception, and knew all that was known about it; so that my Committee readily fell in with the suggestion and agreed to engage him in order that he might have a general control during the erection of the plant. His assistants were also employed, so that they might become familiar with all the details of its construction. Mr. Watts accordingly joined my staff in September, 1887.

In December, 1888, we made several attempts to start work; but structural defects of a more or less serious character were disclosed. This was to be expected, and the only really troublesome one was a leakage in a joint at the bottom of the liquor heaters. This joint being in an inaccessible place, it was found impossible to make it good; and the defect necessitated the closing up of the lowest tray in the heaters after considerable delay and loss of ammonia. Thus the first turning in of gas did not take place until January 25, 1889. The gas, when turned on, at once showed foul at the outlet; but we were encouraged by receiving a report about the third day that it was clean. This proved to be a mistake, and from day to day our feelings were damped by a continuance of impurity in what should have been the clean gas. The extent of this failure varied from the first, not only as regards the total quantity of impurity left in the gas, but also in respect of the proportions of sulphureted hydrogen and carbonic acid forming that total.

The following statement gives details of the working from February 2 (a week after the start) till February 22, when the plant was stopped for repairs. I give it to show the daily variation in the efficiency of the plant; and it may be taken as fairly typical of our experience throughout the experiments. (See Table, p. 85.)

From these figures, it would seem impossible to formulate any distinct theory. On February 2, the total impurity was 4.05 per cent., of which the Claus plant extracted but 1.40, or 34.57 per cent.; while on the following day, the total impurity being 4 per cent., the plant absorbed 2.34, or 58½ per cent. of the whole. It will be observed that the efficiency of the plant as regards carbonic acid and sulphureted hydrogen, when calculated separately, closely corresponds in each case with the total efficiency; being on the first day 35.59 and 31.82 per cent. respectively, and on the second 57.89 and 60 per cent. But if we take the two dates February 7 and 8, we find a very different state of things. The total efficiency on these particular days reached 77.5 and 68.18 per cent. respectively. But taking the impurities separately, we have for carbonic acid on the 7th an efficiency of 75.54 per cent., and on the 8th 76.95 per cent.; whereas as regards sulphureted hydrogen, the figures are relatively 80 and 47.73 per cent. It will be observed, too, that the effectiveness of the process could not be reckoned up by any regular standard of work accomplished.

In the description of the process given by the inventor and the first experimenters, it was suggested that there would be no trouble in dealing with larger or smaller volumes and variety of impurity. It was said to be only necessary to increase or diminish the speed of the various materials through the system, in order to deal with any quantity of gas or any variation in amount or character of impurity. It was, in fact, urged that, in order to effect the greatest economy in purification, only the exact quantity of ammonia necessary to combine with the acid impurities should be passed into the purifying vessels. I am not able to confirm this. My experience has been that the system may be relied upon to take out a varying—I might say an extremely varying—percentage of the impurity; but that only under few and uncertain conditions can it effect complete purification. Let us again refer to our tabulated statement. On February 10, an efficiency of 75 per cent. was achieved with gas containing 4 per cent. of impurity; the quantity dealt with being 2,093,000 cubic feet. If this could be taken as a standard, we might assume that this was equal to the complete purification of 1,570,000 cubic feet. But, as will be seen, the make of 1,564,000 cubic feet passed through on February 5 was not purified, and showed a much lower percentage of efficiency than was obtained with the larger quantity. Again, on February 11, with a reduced percentage of impurity compared with February 10, there was a considerable falling off as regards the purifying powers of the plant. The table furnishes a great number of these seeming vagaries, the causes of which were, and have remained, obscure. This uncertainty of action has been manifested in every stage of the experiments, except during the brief periods when complete purification was effected; and the fact of our having been able to accomplish the latter at one time, while failing at others when the conditions appeared equally favorable, seems at present one of those things that are past comprehension.

On February 22, as already mentioned, we had our first stoppage "to repair liquor tanks." This occupied until March 21, when the gas was again passed through the plant. The production in the section had by this time fallen to about 1½ million cubic feet per day; but the efficiency of the plant was not increased—only about 50 per cent. of the impurity being removed, and the daily variations being if anything more remarkable than before the stoppage. However, as the make decreased, a better efficiency was obtained; and on April 29, with a make of slightly under a million cubic feet, our tests showed that for the first

Date. 1889. Feb.	Gas Passed through Plant. Thousand Cubic Feet.	Total Impurity.			Carbonic Acid.			Sulphureted Hydrogen.		
		In Foul Gas.	At Claus Outlet.	Percentage of Efficiency.	In Foul Gas.	At Claus Outlet.	Percentage of Efficiency.	In Foul Gas.	At Claus Outlet.	Percentage of Efficiency.
2	2,088	4.05	2.65	34.57	2.95	1.90	35.59	1.10	0.75	31.82
3	1,976	4.00	1.66	58.50	2.85	1.20	57.89	1.15	0.46	60.00
4	1,810	5.00	2.60	48.00	3.45	1.76	48.99	1.55	0.84	45.81
5	1,564	5.00	2.80	44.00	3.84	1.97	48.70	1.16	0.83	28.45
6	1,649	3.80	2.00	47.37	2.91	1.41	51.54	0.89	0.59	33.71
7	1,684	4.00	0.90	77.50	2.35	0.57	75.54	1.65	0.33	80.00
8	1,745	4.40	1.40	68.18	3.08	0.71	76.95	1.32	0.69	47.73
9	2,093	4.80	1.80	62.50	3.52	1.00	71.59	1.28	0.80	37.50
10	2,093	4.00	1.00	75.00	2.82	0.62	78.01	1.18	0.38	67.80
11	2,108	3.70	1.50	59.46	2.93	0.93	68.26	0.77	0.57	25.97
12	2,104	3.80	1.40	63.16	2.65	0.92	65.28	1.15	0.48	58.26
13	2,126	5.40	2.40	55.55	3.70	1.30	64.86	1.70	1.10	35.29
14	2,112	4.60	1.40	69.56	2.82	0.67	76.24	1.78	0.73	58.99
15	2,043	4.60	2.00	56.52	3.12	1.14	63.46	1.48	0.86	41.89
16	2,028	6.50	2.40	63.07	4.88	1.31	73.16	1.62	1.09	32.72
17	2,016	4.32	1.80	58.33	3.00	0.81	73.00	1.32	0.99	25.00
18	2,022	4.68	1.80	61.54	3.00	0.91	69.67	1.68	0.89	47.02
19	1,937	5.68	2.20	61.27	4.00	1.05	73.75	1.68	1.15	31.55
20	2,071	5.80	2.40	58.62	4.15	1.31	68.43	1.65	1.09	33.94
21	2,063	4.10	1.00	75.61	3.44	0.70	79.65	0.66	0.30	54.54
22	1,980	5.45	2.00	63.30	4.00	1.14	71.50	1.45	0.86	40.69

Average efficiency for total impurity, 60 per cent.; for carbonic acid, slightly over 66.5 per cent.; for sulphureted hydrogen, a little less than 44 per cent.

time our gas was free from carbonic acid—the sulphureted hydrogen being returned as 7 grains per 100 cubic feet.

At this stage, another problem presented itself for solution. The amount of ammonia in circulation was admittedly in excess of that required theoretically for combination with the acid impurities. In fact, the presence of ammonia was often observable at the outlet, along with sulphureted hydrogen, the latter, according to the returns, varying from a "trace" to 0.66 per cent.—the variation being not only daily, but from hour to hour. As the general tendency was, however, upward, the plant was again shut down for alteration and adjustment on May 17. The principal change considered desirable was in the direction of the flow of liquor through the purifying vessels. Up to this time the order had been 5, 2, 4, 3, 1. On re-starting on June 3, the liquor was distributed thus: 5, 4, 2, 3, 1. The make of gas was continued at about the same rate—1,000,000 cubic feet per day—the season's reductions being made on the other section of the works. The results were very similar to those previously obtained; the sulphureted hydrogen varying during the first fortnight from a "trace" to 0.74 per cent., notwithstanding that ammonia was always present at the outlet. Towards the end of the third week, however, there was a sensible decrease in the impurity; and on June 28, 1889, we were rejoiced to be able to write "Clean at Claus outlet" for the first time.

At last our efforts had been rewarded. We continued to send the gas through our lime purifiers as a precautionary measure; but as day after day passed without necessity for "changing," we felt like those who, having left the desert, had reached the promised land. Our hopes were somewhat damped when, on July 22, the record "Gas dirty at Claus" again appeared. This result was certainly brought about by the carelessness or neglect of the nightman in not attending to his pumps; and on July 25 we were again "clean." So things jogged along until August 10, when the "black mark" had again to be put upon the record. The season having advanced, the make on this day had got up to 1,277,000 cubic feet. On August 13, the gas was again all right though the make had risen to 1,325,000 cubic feet; and all went well till the 30th. The previous day's make of 1,594,000 cubic feet had been perfectly purified, and even at 10 A.M. there was a clean test. But later on in the day—probably owing to an increase of impurity in the foul gas—we had to suffer a reverse, and were once mor depending largely on our lime purifiers. This spell of work was by far the best ever achieved with the plant. From June 20 till August 31—a period of 72 days—no lime purifier required to be changed; and during this time 81,618,000 cubic feet of gas were purified. The reverse was speedily converted into a rout. Within a few days after the gas began to run foul, the whole system seemed to fail. The impurities at the outlet be came greater each day, and on September 11, with 4.4 per cent. in the foul gas and 4 per cent. at the outlet, we had to shut down again. The promised land had vanished. We had short-circuited the desert, and were back again in Egypt.

And now a spectre which had dogged us throughout all our journey came to the front, and insisted on being heard. He took the form of an irate contractor for ammoniacal liquor. From the first starting of the plant, I had been painfully conscious of the presence of free ammonia in the surrounding atmosphere; and the statements of the chemists, that the loss was very slight, but partially reassured me. I was anxious, however, to prove if the system was workable; and therefore urged upon them the necessity for taking in a sufficient quantity of ammoniacal liquor, so that a distinct "Yes" or "No" could be given on this point. The dollars and cents of the question had not so far been considered. Our residual contractor complained that his sales of sulphate had decreased by 50 per cent. during the year; and on going thoroughly over the figures, I found that our deficiency in receipts for liquor amounted to about 45 per cent. This was a serious state of affairs. Whatever there was of an obscure character about the system, one thing was clear as daylight—that it would not pay. It remained to be settled whether we should again take it up, or regard it as an undoubted failure.

The Company naturally wished to think that the failure was caused by errors in connection with the plant. The great defect alleged was the extremely unsatisfactory working of the pumps which had been provided; and it was considered certain that with a better class of apparatus there was nothing to be feared. My Committee agreed to provide a completely new installation, of better construction and larger size. It was also proposed to throw out the existing still and substitute another, but as regards this, we did not feel disposed to incur any further expense unless the cost was shared, and our payment made conditional on the success of the system ultimately. This was finally agreed to, and the work of reconstruction, renewal and repairs, was again proceeded with.

This overhaul occupied nearly a year, so that it was August 26, 1890, before we were again ready for a start. The valves were opened on that date, but, the direct connection to the lime purifiers not being closed, little gas passed through the Claus vessels, and what came was foul. Our first trouble was the blowing of the new still on September 4. This necessitated a stoppage, and we were off for a week, making alterations and deepening the seal of the still. On September 11 the whole make of the section was turned through, amounting to close upon 2,000,000 cubic feet, and the outlet gas was foul from the start. On September 15 the still again blew, and the plant had to be turned off. Further alterations were made and work was resumed on the 16th. Matters remained unchanged until October 14, when we took a large portion of the gas hitherto passing through the plant to the other section of the works, to make preparation for the season's arrangements. The gas passing through the Claus plant being thus for the moment reduced to a little over a million cubic feet per day, a clean test was obtained on October 16; but with an increase to 1½ million feet on October 22, dirty paper was again registered. On November 5 the apparatus had to be closed down "to repair carbonator," and this job occupied till November 19, when another start was made. No further change took place till January 11, 1891, when the still, which had been giving more or less trouble all along, got blocked, and another stoppage was necessitated. Four days were taken for the work. Resuming on January 20, we went on in a most uneventful way until May 12, when another, and as it was then thought, a final stoppage was made, which was chiefly the result of a second interview with the "spectre."

During the heavy winter months, the gas passing through the system had been in excess of 3,000,000 cubic feet per diem ; so I had no expectation of realizing a complete purification by means of the Claus plant, and could only gauge its results by the percentage of efficiency obtained. This was, as before, very variable. It became clear, however, that, notwithstanding all the changes that had been made, and spite of the protestations of the chemists that there was no appreciable loss of ammonia, our revenue from this residual was suffering keenly. On January 13, 1891, I wrote to the Ammonia Company to this effect. A rather voluminous correspondence ensued, in the course of which the Ammonia Company requested me to allow our chemist to proceed to London to consult with them as to the position of the undertaking, and the possibility of making it a success. It had become quite clear that, unless something in the way of improvement could be effected, the loss of ammonia alone would condemn it, even were it in other respects satisfactory.

It will be seen that Mr. Watts might be regarded as, in all respects, more the representative of the Ammonia Company than ours, during all the time the experiments were going on. This was but natural. We regarded the interests of the Company as identical with our own, and we all looked to Mr. Watts as the receptacle of all the knowledge available in reference to the system. I cheerfully pay Mr. Watts the tribute of saying that no man could have more thoroughly worked for and desired the success of an undertaking than did he during the years this scheme was under trial ; and I am bound to say that if he failed to make it a success, I have but little hope of anyone else succeeding. No doubt, like many a foster parent, he was a little blind to the faults of the child of his adoption—a very natural and very amiable tendency. Feeling thus, it will readily be understood why the whole expenditure on, and working of the plant were left entirely in his hands ; and the Ammonia Company were as well acquainted with everything that was going on as we were ourselves.

However, to return to the "spectre." It appeared that the loss of ammonia during the month of January, 1891, was well on to 20 per cent. of the whole production ; and the February results were even worse. The loss by this time was undeniable ; and but for the fact that our limited space was bunged up with refuse lime, and we desired to reduce as far as possible the production of this residual, we should have at once shut down. Mr. Watts meanwhile reported to the Company what alterations he considered should be made to perfect the apparatus ; and these were of a very expensive character. Negotiations were again opened by the Company for another complete overhaul, which was to be done at their cost, but on the condition that they should be recouped if success were achieved. They were to have complete control over the whole apparatus, and in the meantime pay all expenses. All these matters having been arranged, the plant was put out of action on May 12, 1891, and left entirely in the hands of the Company to effect such changes or repairs as they might deem necessary. As regards these changes, I took no part in arranging them, but tried to impress upon the Company the importance of having everything perfect for the next trial, as it would be most unfortunate if we had again to start and stop.

About 11 months were occupied in the overhaul and partial reconstruction of the plant. We made an unsuccessful effort to recommence work on March 25, 1892, and another on April 1 ; the failure in the latter case being due to the blowing of the still. On making a third attempt on April 8, things were as bad as ever. This was not a very encouraging beginning, after almost a year's preparation. Finally it was discovered that the pipe between the purifying plant and the sulphur kiln had become blocked with carbonate of ammonia. After cleaning this out, we got again to work on April 14, 1892, our make of gas on the section being just 2¼ million cubic feet. The gas was quite dirty at the outlet, and the still continued to blow periodically, with great loss of ammonia.

As regards the efficiency of the plant at this period, our purifying figures led us to a different conclusion from that arrived at by the chemists' analyses of the gas before and after passing through the apparatus. According to the latter, from 50 to 75 per cent. of the total impurity was removed. Calculated on the quality of lime used before and after the re-starting of the apparatus, the saving did not represent more than about 30 per cent. Our daily make got gradually down ; but we seemed to be as far as ever from the achievement of our wishes. The sulphur kiln began also to give us trouble. The brickwork became saturated with the condensed vapors from the kilns, and the joints got leaky, the gases passing through and causing great complaint. As it appeared impossible to improve on this state of matters, and the plant had been inefficient even with the midsummer make, it seemed useless to continue it in use; and accordingly operations were again suspended on June 6, 1892. Up to this time, counting from the first actual starting of the plant to work, 1,215 days had elapsed, during 475 of which gas had been passing through it, the remaining 740 days having been occupied in repairs, alterations and renewals.

Matters had now come to a deadlock, and we practically decided to write the whole thing out of our books. The Company, however, again reopened negotiations ; and as the result of numerous letters and interviews, it was decided to hand over the plant to them, to be by them put in order and operated. Accordingly, they started to overhaul the apparatus, which was not ready for work till May 12, 1893. On this date the gas was turned through, but the outlet showed a dirty test, though the quantity passed was only about 700,000 cubic feet per day. On May 21, the gas was free from sulphureted hydrogen ; and this condition of affairs continued till July 4, with the exception of one day, when it showed a dirty test. Unfortunately, the experiment had to be interrupted, in order to effect an overhaul and reconstruction of the works' mains ; and on the date mentioned all the gas was turned into the other section of the works. Work was resumed on August 23, and the gas was clean at the outlet; but at intervals it ran foul until August 30, when a complete block occurred, necessitating a stoppage of the plant.

A week was occupied in cleaning out, and on September 6 work was once more resumed with a clean outlet. From this date until October 4, the second best set of results was obtained, the gas being generally clean at the outlet, though on 16 days there was a trace of impurity present. The uncertainty of action, however, was most strikingly indicated during this period, as on one day 1,816,000 cubic feet were perfectly purified, whereas on another day there was a dirty test with a make of under a million feet. Also taking two consecutive days, the purification was imperfect with a make of 1,158,000 cubic feet on the first day, and absolutely perfect the following day with a production of 1,353,000 cubic feet ; the purity in the foul gas being 6 per cent. greater on the day of the larger make. On October 14 the make of gas was gradually increased, and the outlet always showed a foul test. The new carbureted water gas plant was by this time approaching completion, and as it had been determined to pass the new gas through this system, a stoppage was made on November 19 to have everything put into complete order. To keep things safe, the connections from the outlet of the Claus apparatus were laid to a new station meter, and the exhauster outlets were so arranged that the carbureted water gas could be (*a*) passed direct from the Claus plant to the gasholder through this meter, (*b*) passed through this meter by a special inlet, and after being measured foul sent on to mix with the ordinary gas for purification, or (*c*) passed direct into the coal gas mains at the scrubber inlets.

Our first make of water gas commenced at Christmas, 1893. You will be aware that the quantity of sulphureted hydrogen in carbureted water gas is very small—say, about 0.15 per cent. in the foul gas—and our start was a very hopeful one, the test being perfectly clean. Little troubles occurred from time to time, such as the blocking of pumps owing to deposit of pitchy material dissolved out of the purifying vessels by the new gas ; and there were frequent stoppages, which with coal gas works would have been highly inconvenient, but which, owing to the latitude in working conditions available with the water gas plant, were safely tided over. As the autumn advanced, these little worries became more frequent and alarming, and we had to face the winter of 1894–5 with anything but cheerful feelings, as, being disappointed of the use of new purifiers on which we had reckoned, we felt that, notwithstanding all our arrangements for duplicating the working mains, the available purifiers were utterly inadequate to deal with the united make of coal and water gas if it became necessary to turn the latter over to them. A most anxious season was passed, and it was quite evident that we could not continue to work the plant without a complete overhaul and partial reconstruction.

Later on in the season, scarcely a day passed without some trouble cropping up, and we waited for the spring with feelings somewhat akin to those with which the crew of a water-logged ship long for the sight of a friendly sail. We had the good fortune to keep things going till February 7, 1895, by which time the demand for gas had considerably fallen off. On that day, without a moment's warning, our troubles, most of which were of a mechanical sort, culminated in the collapse of the ammonia cooler. Work with the water gas plant was at once suspended, until the necessary valve changes had been made ; and when the order was given to resume, we watched our gauges with the utmost anxiety. To our great relief, we found the pressure well within the control of our syphons ; and never, to pursue our analogy, did weary seamen leave a sinking ship and step upon the deck of a sound and sea

worthy craft with a greater sense of relief than we felt when, bidding adieu to "purification in close vessels by ammonia," we found ourselves once more depending on our tried old friend hydrate of lime!

With this collapse ended our experiments with the Claus system of purification. I am glad to say that most of the plant has been, or will be, worked in for use; and probably the ammoniacal liquor heaters and the sulphur recovery apparatus will be the only portion not so available. The cost of working and repairs has, of course, been paid for out of current revenue.

I do not propose to attempt any speculative inquiry into the reasons why better results were not obtained. The work has been carried on throughout under the particular care of two—and for a long period three—well qualified chemists; and as they have been baffled in their investigations, it would be in vain for me to attempt the solution of so difficult a problem. A few practical items of information have, however, resulted from our labors, and to these I shall as briefly as possible refer.

As regards first cost, the claim that it is a cheaper plant must be withdrawn. Our plant cost $72,500, and was supposed to be equal to the purification of 2½ million cubic feet of gas per day. Even had it proved to be capable of performing this duty, such a cost would be much in excess of that of ordinary purifiers. Economy of space cannot be effected if we include the ground occupied by the sulphur recovery kilns and chambers. In this connection I may say that one of the most plausible reason advanced for the failure of the experiments was that the vessels were too small, and did not in consequence give sufficient time for the completion of the chemical process. If this theory be accepted, clearly more space would have to be occupied and greater cost incurred in attempting future installations.

To the extreme uncertainty of action, I have already referred. To this I must add that ordinary care and attention are not sufficient for carrying on the process. Those in charge must not only be trained chemists, but must also have thorough practical experience of the working of this particular plant. In case of the illness of one of the regular staff, it would be almost impossible for a stranger to take up the work, even though he were well acquainted with the theory of the system and the general construction of the apparatus. The multiplicity of the pumps—eight requiring to be in constant use—and the difficulty of keeping them in efficient working order, add not a little to the responsibility of those in charge.

Another fact seems to have been very clearly established—viz., that the analysis of the liquor in the various vessels could not be relied on as an indication of the purifying powers of the plant; and that this latter must depend on conditions unascertainable by those in charge. Thus at one time a large volume of strong ammoniacal liquor was returned to the well without affecting sensibly the stock of ammonia in the vessels as ascertained by an analysis of the liquors, while at another time a very large amount of ammoniacal liquor was taken into the plant without showing a corresponding increase in the strength of the liquors in the vessels. Hence, while going on apparently satisfactorily and unable to detect any change in the conditions of working, the subtle reactions taking place inside the vessels seemed to wear away our unknown margin of safety till, like the "bolt from the blue," came the announcement, "Gas dirty at Claus outlet." Such a condition is bad enough with ordinary purifiers, but with them a change is easily made and matters set right. No such remedy is open in the other case. The system is, for the time being at least, upset; and the only thing to be done is to endeavor to restore the conditions—apparently very uncertain in their character—under which the work had been previously carried on. Sometimes this was achieved in a day or two; sometimes—well, sometimes it wasn't.

I need hardly say how much more pleasant it would have been to me to chronicle a success rather than record a failure. I at first entertained the brightest hopes; and it was only when I realized that, notwithstanding the most skillful oversight and care, the system was not likely to be able to stand alone, but required behind it a catch system equal to the performance of the whole work in order to keep matters straight, that I somewhat lost heart and interest in it. In May, 1886, when recommending my Committee to take up the process, I referred to the closing paragraph of the chapter on Purification in "King's Treatise," in which the probability is referred to that eventually such work would be effected in close vessels, perhaps by the very ammonia contained in the crude gas itself, and said: "In this forecast of the improvements most to be desired in gas purification, the Claus system is literally described; and if its adoption is decided on, I trust and believe that the results will be in the highest degree satisfactory." In February, 1894, in a letter to a friend who had made inquiry as to how we were getting on, I wrote as follows: "Theoretically it is a very beautiful system; but in practice it seems to me that there are such numberless causes, some of them of a very trifling character, which are quite sufficient to upset the working, that I fear there is little chance of it taking the place of some of the older if less scientific systems."

In these two extracts are epitomized the results of eight years' experiments. I wish they had led me to form a different opinion. I should be glad to hear that a system which so much appeals to us as representing the theoretical perfection of gas purification could be got to work, and that someone had succeeded where I failed.

Gas Distribution in Relation to Modern Municipal Development.

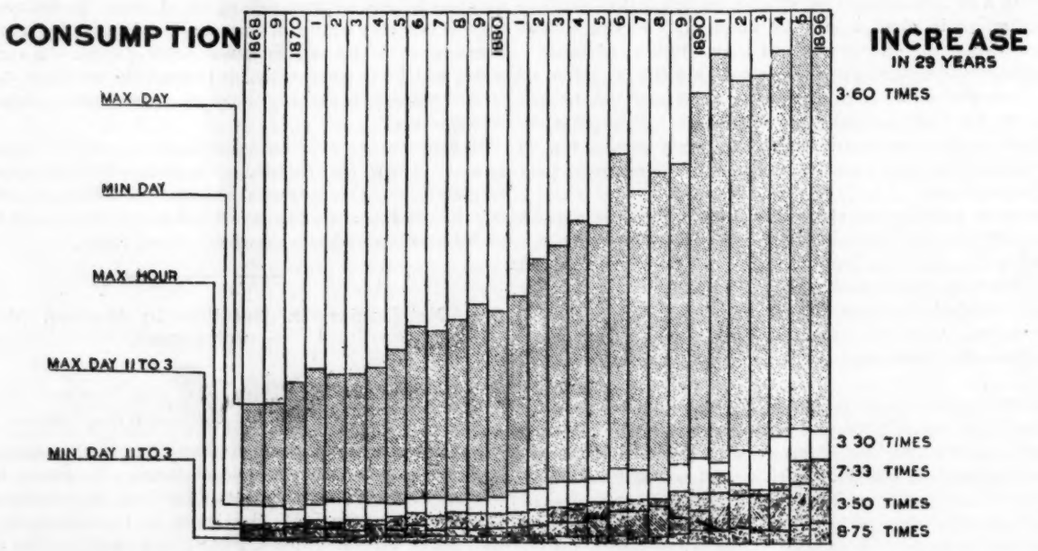
[A paper read by Mr. Thomas Canning, Newport (Mon.), at the 34th Meeting of the Incorporated Gas Institute.]

A characteristic feature of civilization in the Nineteenth Century has been the development of cities and towns. In Great Britain this development of urban concentration has been more marked than in any other country. Sir J. W. Bazalgette, in his address in 1884 to the Institution of Civil Engineers, pointed out that London is "without a rival as regards its size and population, not only in the present, but, as far as we know, in the past history of the world." Its present population is equal to the aggregate population of the three great cities of the ancient world—Rome, Carthage and Babylon—with the population of the modern city of New York superadded. In 10 years it has advanced about 400,000—a number equivalent to the entire population of Leeds. The population of 35 of the largest towns of Great Britain and Ireland, outside of the metropolis, was in 1886 6,386,385, and in 1896 7,484,939, being an increase of 1,098,554, or equal to the entire population of Berlin. Other places are rapidly rising up that will, before another decade has passed, reach the 100,000 limit necessary to bring them under the category of a large town. It is noticeable, however, that the metropolis has now a lower rate of increase than the provincial cities and towns. In 10 years London has increased only 10 per cent., while in provincial centers the increase has been at the rate of 17 per cent.

Government—municipal government—was early found necessary to meet the requirements of the ever-growing urban populations; and wherever such government became established vast signs of change at once appeared. Boundaries were enlarged, new streets were opened, old streets rebuilt (often their lines of frontage altered to make carriage ways and footways wider); while, again, these routes for vehicular and foot passenger traffic have been paved by new methods and with new materials—the chief novelties consisting of wood, asphalt, brick, granite sets and cement concrete paving. The drainage, the water supply, the lighting and the locomotion in town thoroughfares have all undergone a great revolution within the past 25 years, and surprisingly so within the last decade. Electricity, too, has come upon the scene, for the supply of both light and motive power; and it is likely in the future to be employed considerably in tramway traction.

Electric lighting is the spoiled child of municipal benevolence. No other industry owes so much to municipal fostering; but there can be no right to credit of enterprise in such undertakings, for no risk is involved. It would, however, be an error to suppose that electric lighting owes all its progress to municipal aid. In the provincial cities and towns electric light supply has been the result mainly of the efforts of the municipalities, but the capital of private electric light undertakings, especially in London, is, up to the present, very considerably beyond that of municipal concerns. Another error is to suppose that in bringing the excellent Welsbach light into competition with the incandescent electric lamp, the gas manager may rest contented. The Welsbach light has been successful, and deservedly so, but it does not answer all the requirements of gas managers. The field is still open for the introduction of an improved burner, which need not necessarily be of the incandescent type. The gas industry has, fortunately, suffered little from the adoption of its favored rival. But this should be a reason for those engaged in it not to relax, but to redouble their energy and vigilance.

In work affecting gas affairs but little—such as technical education, providing parks, libraries, museums, fire brigade stations and hospitals—municipalities have been also occupied. To sum up they have created, in all, developments as rapid as unexpected, and largely influencing the question of gas distribution. The author considered the foregoing remarks would not be inopportune as serving as an introduction to a



fuller treatment of what cannot but be regarded as a most important subject.

Two processes go on simultaneously in growing towns—an extension at the limits and consolidation at the center—the causes of which it is not necessary here to explain. Mains of larger diameter than were formerly needed are required, not only as regards actual supply of extended area, but proportionately as regards the districts. Thirty years ago gas was taken from the main by a small number of consumers for one purpose only—viz., lighting. At the present time the mains are drawn upon by a large number, and at certain hours simultaneously, for at least four purposes. Mains too, are reached, repaired, renewed, or extended now with ever increasing difficulty, risk, and expenditure. Hence no subject requires more attention than the correct proportioning of mains to the supply. The maximum hour's consumption must determine the diameter of the district trunk main, whether a service main or an independent main.

Proportioning Mains.—In the diagram exhibited, the author shows how, in a progressive gas undertaking, the maximum day's consumption has increased since 1868, also the proportion borne to this by the minimum day's consumption; that of the maximum hour; and the consumption from 11 A.M. to 3 P.M. The proportions are accurate, and actually represent the advance made, and the rate of progress. The maximum consumption in 24 hours has multiplied 3.6 times in 28 years; the maximum hour's consumption has increased 3.5 times; the minimum day's consumption has advanced 3.3 times. But on the minimum day the consumption between 11 A.M. and 3 P.M. has increased 8.75 times; and on the maximum day the consumption for these four hours has increased 7.33 times. It is satisfactory to note that the middle day consumption of gas in summer exhibits the largest increase of all. In 1868 the maximum hour was 114-thousandths of the maximum day's consumption; but in 1896 it was 106-thousandths. It is a good sign of steady advance when, in a progressive concern, the maximum hour's consumption recedes in comparison with that of the maximum day. The maximum hour's consumption, then, is about one-tenth that of the maximum day; but the author has reason to believe that it varies in different centers.

No general conclusion can be based on a single case—for example, in a manufacturing city like Oldham the maximum hour's consumption must be a large proportion of that of the maximum day. In deciding, then, the diameter of a trunk main, it is necessary, first of all, to estimate what the maximum day's consumption may be, say, 20 years later. Twenty years, while too long a period for anticipation in regard to provision for manufacture and storage, is not, the author believes, too long with reference to distribution. It may, perhaps, be considered too short a time, as many mains have been known to live and thrive for 50 years. But in large centers of population opportunities of duplication may occur; and, considering all circumstances, 20 years may be accepted as the period to be taken into calculation for arriving at the diameter of the trunk main. Dividing the prospective maximum day's demand at the end of 20 years by the number of maximum hour's proportion, and calculating the diameter of the main that will supply this at the required distance under the necessary pressure, will give the result desired.

With reference to the replacing of one main by another of larger diameter, a fallacy exists in some quarters that the supplying capacities of the mains vary as the squares of their diameters. As a matter of fact, the capacity variation is as the square root of the fifth power of the diameter, expressed by the formula: Relative discharging capacity of pipes $= \sqrt{d^5}$; where d = the diameter in feet or decimal parts of a foot. The formula is founded upon the principle common to mathematics and physics—to theory and to experience—that the volume of fluid delivered by a pipe is equal to the product of the sectional area of the pipe multiplied by the mean velocity of the flow. In its results the formula is in close correspondence with the figures given in Barlow's and Newbigging's tables in the second volume of "King's Treatise on Coal Gas" (calculated from Pole's formula), p. 382.

As an example of the application of the above formula, a 12-inch main under 2 inches pressure delivers 33,600 cubic feet of gas per hour at the end of 2,000 yards, it is required to find what a 14-inch main, under the same conditions, will deliver. The square roots of the fifth powers of the diameters (12 and 14) are as 1 : 1.47. $33{,}600 \times 1.47 = 49{,}392$ cubic feet, the discharging capacity required. The figure given in Barlow's tables for corresponding conditions is 49,400 cubic feet. So, in like manner, a 12-inch main compared with an 18-inch one is as 1 : 2.756; and, again, it will be found that the result corresponds with the tables. By the old rule a 24-inch main was considered equal to four 12-inch ones. It is really equal to 5.657 12-inch mains. It may be questioned, then, if there is any need for the formula. It brings out prominently the fact that a 24-inch main can supply 32 6-inch pipes, and not 16 only, as too frequently stated. It is a proportioning formula, and so therefore has its own use.

Objections may be raised to the use of formulæ, the results of experience being preferred. But the author is endeavoring to indicate that experience is daily changing under new environment, one result of which is that the diameter of the average main in most progressive gas undertakings will have to be increased in future to a degree not contemplated within former experience. He has shown that by means of the maximum hour's consumption a starting base is at once obtained; and, knowing the quantity to be supplied through a certain distance under a certain pressure, much assistance can then be derived from reliable formulæ, tested in practice.

It will be generally agreed that manufacture of gas should be concentrated as much as possible, and that to multiply manufacturing stations is not economical. It is found necessary to erect distributing stations in growing centers; but this is not always desirable.

Street Paving.—Great changes have been made in the street pavings of large towns. The use of any kind of street paving requiring a cement concrete bed has the effect of rendering the detection of gas escapes very difficult. When the carriageway pavement is of wood or asphalt, and that of the footways of granolithic cement, this detection becomes impossible until the gas has made its way into the cellars of the frontagers, which may be too late. The author's practice is to examine, and renew or repair if required, all mains and services at the time the road is stripped for first laying such pavements. For detecting leaks he has fitted into wood pavements a small shaft with a strong

cast iron cover, leading from the surface down to the main. These are fixed at reasonable intervals apart; and an inspector opens and examines them from time to time. They not only indicate an escape but enable its position to be pretty closely determined. They also help to dissipate the rush of gas, if any. Beneath the granolithic pavement are placed, in the proper situations, 3-inch glazed earthenware pipes, through which the house services pass. Their advantages are obvious. Glazed earthenware is preferred to cast iron, for the lengths are more suitable to the irregular widths of pavement, and the difficulties of rust are avoided. It is well to follow a similar plan for services under tram lines, as it is always easy to drive a boring beneath them. In this case, however, the outer pipe should be metal.

It has been suggested that double lines of service mains should be laid, one on each side of the street—so avoiding opening all across a street for long services. In view of what has already been said as to proportioning mains, such a plan can only be regarded advisable in very wide and the very busy thoroughfares. Mains under pavements are objectionable. As to subways, they are too costly to become general. In the principal thoroughfares of very large cities numerous subterranean streets for pipes and heavy traffic, with communication to basements, if properly ventilated, would have great advantages.

The introduction of electric lighting has added a fresh cause of expense, and some anxiety, to the sellers of gas. The law, to some extent, protects the gas distributer, but there are still cases of hardship requiring some redress. Gas is reported in a transformer box; but the leak may be far away from the box, and the gas may have penetrated to the box from a remote point, through a defective electric culvert. The search for the leak may be long and costly, and there are no means within the author's knowledge of locating the small defects in electric culverts. It is only too true that a defective culvert is very bad for the electrical distributer; and as electricians and gas men are equally interested, the difficulty ought to be soon overcome.

Increased traffic, producing greater vibration, is a cause of considerable disturbance to gas mains. The weight of traffic passing over each yard in width of busy thoroughfares varies, per diem, from 250 tons in less busy streets to 1,400 tons in the busiest; and this weight will eventually tell upon pipes beneath the surface where the subsoil is shaky. In the case of the steam roller, it is the vibration caused by its hammer-like motion over pipes laid upon infirm substrata that causes breakage.

The jerry-builder—an obnoxious parasite on municipal development—has often been, and will continue to be, a very disturbing element as regards the soundness of pipes. By a section of the Public Health Act, owners and occupiers have a right to connect their house drains to the street sewer. The jerry-builder most frequently does this, and it means destruction to any gas pipe laid previous to his operations, as he neither fills nor rams the excavations adequately. He is supposed to do his work under inspection; but inspection can only be intermittent. The result is therefore most unsatisfactory.

Electrolysis of Pipes.—To substitute electric energy for horse traction as the motive power for tramcars is an idea that possesses some municipalities, especially those with an electricity supply works. Gas is certainly more easily applicable, equally efficient, and quite as economical. Many suppose that electricity from an electric light station applied to traction would reduce the cost of the current. Only to a slight extent would this be the case, for one set of generators could not energize trams, start them and stop them, and keep up at the same time steady lights. But this is not the point. Rightly or wrongly, the idea of electric traction is in the air, and what has to be examined is, Are the return currents likely to injure gas pipes? If so, to what extent; and is this injury preventible, and how?

The motive power to the trams is supplied from the power house, situated generally equidistant from the termini. The system at Bristol is a fairly typical one. In this installation there are three slow speed continuous-current dynamos, capable of yielding an output of 200 amperes at 550 volts, when running at 650 revolutions per minute. Two complete trolley wires run from end to end of the line for supplying current to cars running in opposite directions. The return current passes through the rails, which are connected electrically at the joints by what is called the "Chicago" rail bond—that is, two copper rods of 0.4-inch diameter, each flattened out at the ends, and connected by steel pins with the rails.

To briefly summarize a description of the electrolytic process, it may be stated to consist of the decomposition of liquids by means of electric currents; the liquid so decomposed being called the electrolyte. Electrolysis is thus chemical change produced by electric current. In the ordinary voltaic cell the converse occurs, and the effect is chemico-electric, for an electric current is produced by chemical action. The earth impregnated with moisture, often containing acids, underlying the surfaces of streets is capable of becoming an electrolyte. When an electric current passes in common water from one metal plate to another, the fluid is decomposed, oxygen going to the positive plate and hydrogen to the negative plate. The immersed surfaces of these metals are known as electrodes or poles, the positive pole being called the anode, and the negative pole the cathode. If the metal of the anode is oxidizable, it will corrode from the liberation of oxygen and acids there, while the negative plate at least suffers no injury. If an electric current finds it easier to take part of its way back to the power house through an underground pipe, or pass from one pipe to another, if the pipe is positive to the rail, then at whatever place or places the the current leaves the pipe to go to another, or back to the rail, at such place or places the pipe will be eaten away, and in time be utterly destroyed. Salts, acids and escaping gas increase this action; and salts—especially chloride of sodium and sulphates of various alkaline bases—are very abundant in seaport towns, and, with the exception of the former, equally abundant in those inland.

Naturally, on account of the extensive introduction of street railways in America, more experience of this electro-chemical corrosion of pipes has been obtained there than in England; and in connection with this part of the paper the author has to record his indebtedness to Mr. W. R. Addicks, of Boston, to the AMERICAN GAS LIGHT JOURNAL, to the report of the Committee on Electrolysis of the Western Gas Association, and to the researches of Mr. Harold P. Brown, electrical expert, of Edison Building, New York. In the earlier electric tramways in America no special provision was made for conducting the return current to the power house. It was an axiom, but a false one, that the earth is a conductor of which, practically, the resistance is zero and the capacity infinite. When, later on, it became apparent that this was an error, bond wires were introduced into the rail joints, much as above described, so as to make the rails the vehicle for the return current. But all this took some time. It was a long while before gas managers found out the damage, and naturally longer still before tramway managers were brought to acknowledge it. It is but very recently, indeed, that the effect of electrolytic action on pipes has been realized to any extent.

In a paper published on 18th February, 1895, Mr. Harold P. Brown says: "The recent rapid growth of electric railways through the streets of our cities has produced conditions whose seriousness is not yet fully realized. Within the past few months, however, some of the most alert railway managers have realized that they are throwing away hundreds of horse power every day in the work of injuring water, gas and subway investments, and that some day they will be called upon to make good this damage." This may be so in America, it will be said, but in England the Board of Trade does not permit this loss. The Board directs that the difference of potential between the terminals of the uninsulated return shall be recorded. This difference is allowed to be as high as 10 volts. There is nothing to show by what route the return current comes, whether wholly by the rails or partly by the rails and partly by the pipes. The record, to be useful for this purpose, should be supplemented from time to time by giving the difference of potential between the trolley and the rail, the trolley and some pipe or pipes likely to be affected, and between the rail and the pipes. The electric energy required to decompose any compound is only about the equivalent of the quantity of heat evolved by its constituents when uniting. Taking water, 1 gramme of hydrogen and 8 of oxygen, in burning to 9 grammes of water, evolve 34,500 centigramme calories. A volt corresponds to about 22,900 calories. Hence

$$\frac{34,500}{22,900} = 1.50 \text{ volt},$$

the voltage of the electromotive force required for water electrolysis—the most common. This would be produced by the presence of acids; and looking at this small voltage it is evidently most desirable that the tests indicated should be made.

In their report on electrolysis presented to the Western Gas Association, the Committee state, after reviewing schemes many of which are more complete than any thought of yet in England for preventing electrolysis: "As deterrents or diminishers, many of them assist, but not one fulfils the requirements of complete protection, nor can any system do so which uses the rails to any appreciable degree as conductors. * * * The pipes will be called upon to bear a portion of the current under the most favorable circumstances, and in so doing will be injured; for it has been shown by experiment, under conditions identical with those existing in practice, that electrolytic action may occur within differences of potential of 0.5 volt."

No more perfect system of return conduction is applied here, or proposed to be applied, than in America, yet Mr. Harold P. Brown says:

"Assuming that bond wires [rail bonds] are perfect, and the feeder wires ample, it is, of course, true that the current flowing on the pipes would be reduced; yet they would still carry a considerable proportion, and still suffer corrosion at the points where the current left them." The truth of this must be clear when the large cross-sectional area of metal in the pipe network of any town and the laws of conductivity are taken into account. As a fact, the pipes are, in cases of poor bonding, the best conductors. It cannot, either, be argued for a moment that the concrete road bed is an insulator.

It may be thought that water mains will protect gas mains, and that, being usually larger in area and filled with water, they will carry off the current. This is true to a certain extent, but their superior conductivity is of no avail to save gas pipes. The current will always take the shorter route, and will be now in a gas main now in a water main; and the more pipes there are in a street the more will be the electrolytic injury done by the current leaving one to pass to another. If water pipes have cemented, half turned and bored joints, and those of the gas pipes are turned and bored, or lead only, the gas pipes will be the better conductors.

There is no need to recapitulate the accounts of disasters to pipes throughout the United States, in which destruction was wrought in periods varying from five months to five years. When the cause was discovered various remedies were proposed. The earliest plan seems to have been the coating of the pipes with non-conducting paint. Besides being impracticable, as regards a whole district, the current, where it was tried, entered at weak places and left at any point, destroying the pipe where it passed off. Pipes were laid in cement-jointed drain pipes, but this also failed. At Los Angeles the water pipes were laid in conduits filled with sawdust, and in other places in conduits filled with pitch. These proved only examples of costly failures, for it is evident their use could be only partial, and no partial adoption of them could be of any value. Paralleling gas mains and avoiding cross connections also failed, and cement joints proved a source of danger. The efforts of the water and gas authorities were supplemented by endeavors on the part of the electricians to discover a solution of the difficulty.

Rail bonds and feeder wires (these latter insulated) have already been referred to. These also failed to afford a remedy, though they diminished the damage. Many of the early electric railway constructors connected the rails to the pipes, and some tried reversal of current, with deplorably evil results. In Cambridge (Mass.) the scientific investigation of this problem was first begun by Messrs. Nevons (water engineer), Allyn (gas engineer), and Morse and Pearson (electricians). To save the water pipes, a copper circuit was laid from them to the power house. The current then left the gas mains for this new route, destroying them as it did so. The Committee of the Western Gas Association saw no salvation except in the double trolley system—that is, a plan by which the current would return overhead, and not pass through rails or pipes. This plan would meet the difficulty, but great risk of fire is involved; and, in a strike for instance, a piece of wire thrown across two trolleys (the supply and return) would cause both to fuse. The three-wire system has also been tried, but with 1,100 volts between two wires it will not commend itself to public authorities. More may be heard of this system. It is now under the consideration of English electricians, but, as tried in America, it has not succeeded. It was also suggested to, as it were, pump current from the pipe to the rail by a motor dynamo, so as to make the rail positive to the pipe; but this plan, the author believes, has not been tried. Rail and pipe feeder wires of every kind have been attempted, and all have failed.

The views of British electricians upon this very important matter have been recently expressed. Speaking at a meeting of the Institution of Electrical Engineers, on the 8th April of this year, Mr. Stephen Sellon, in the discussion of a paper on "Traction," described the importance he attached to bonding. "Time was spent," he said, "in discussing whether one dynamo was better than another, or whether one engine was better for a certain purpose; but the point to be considered, and upon which the success of electric traction depended in this country, was the question of leakage. * * * If once they got electrolysis going on in any of the gas or water pipes belonging to municipal authorities, it would mean a death-blow to electric traction in England." He then spoke of the careless bonding done by manufacturers, and gave it as his opinion that they had not yet learned the "mere alpha of the whole business." Mr. W. H. Preece described the leakage on the South London line near Clapham, and the injury done to the telephone wires. Commenting on this discussion, the *Electrician* says, in its leader of the 30th April last, that "time spent in discussing dynamos and direct driving was wasted, when the real point at issue was how best to prevent large leakage to earth and the consequent wholesale electrolytic dissolution of our gas and water pipes. * * * If the earth return is to play such a palmary part, it may perhaps prove worth while, after all, to fall in with Professor Ayrton's views, and thoroughly insulate the return."

Besides the idea of insulating the return, a plan has been tried by Mr. Harold P. Brown. He considers it indispensably necessary to keep the pipes at least 1 volt negative to the rails, to diminish the current on them, and to make a permanent non oxidizable low resistance connection with the feeder wires. His plan may be shortly described as follows: Beside the dynamo battery working the station, a dynamo runs at 12 volts higher. By suitable wires the negative pole of this is connected to the pipes by a patent method, the positive pole being connected with the trolley as usual. He claims that by his arrangement the pipes are always negative to the rails; and the rails can afford the loss which the pipes could not.

The author's conclusions are that so long as the return current, in any shape or form, passes back to the power house by the uninsulated rails, electrolytic action, destructive to gas and water mains, will go on; and, further, that proper electric tests, made by qualified persons, should be regularly applied to determine the electric condition of the pipes. Lastly, it is the duty and to the interest of electricians to provide for underground pipes adequate protection from electrolytic action, and the gas manager has to observe that these requirements are satisfactorily met.

Some Lighting Systems in Russia.

By Mr. M. Lutoslawski, in *Electrical World*.

Russia and the almost unpopulated regions of America should show certain analogies in consequence of their mutual scarcity of civilization, but at the the same time they exhibit a striking contrast regarding the ways in which progress advances in the two countries.

The circumstances under which technics develop in Russia must really appear inconceivable to an American. With the exception of two or three large cities, there has been indicated only very recently a demand for electric light plants. In order to supply this apparent necessity of progress, some local companies have been formed for the purpose of competing with the agents of foreign firms—generally German firms, which so far have had no competition.

The manufacture of electrical apparatus is still entirely undeveloped. Outside of the firm of Siemens & Halske, in St. Petersburg, there are only two or three small factories, and these manufacture dynamos under licenses from foreign firms. Large installing firms have gradually grown up, among whom the firm of Podobjedow, in Moscow, has been up to the present the leading one. A few months ago a new Company, "Electricity" (Towarzystowakcvjne Elektrycznosc), was formed in Warsaw, to some extent backed up by the Allgemeine Electricitats Gesellschaft, in Berlin. This is one of the few firms constructing central stations and electric roads.

The above firms and the various agents of foreign houses have received of late numerous inquiries from small and large towns which intend to improve their systems of illumination.

Most of these negotiations, however, do not lead to actual business, as the electrical houses cannot accept the conditions made by the town authorities. Several reasons tend to explain this. First, the lack of luxuries in general, and of light in particular, is in Russia so striking that the corresponding data would simply appear incredible to an inhabitant of the Western Continent. A small city, say of 20,000 inhabitants, expends as a maximum annually 1,500 to 2,000 rubles ($750 to $1,000) for illumination. This, however, does not imply that the town really is lighted to an extent equivalent to that which should be obtained with this amount. Large sums are employed to increase in such illegal but quite customary way the insufficient salary of some members of the town authorities, and the electrical contractor must agree to conditions which secure to himself an extra profit and permit of bribing people having any connection with the question.

The lights burn only on the nights and at the hours when there is no moonlight indicated on the calendar, and burn during the prescribed hours only when a higher government officer may be present who is not accessible to the usual limits of corruptibility, or if any other important personage of rank is expected.

Second, the knowledge of technics and of the cost of plants is extremely small, so that the town authorities have no idea of the cost of the plant they need, and in most cases break off negotiations after receiving an estimate from the electrical contractor. The cities usually

agree to increase their expense for illumination a little when the introduction of electric lights is intended, but at the same time the authorities increase enormously their pretensions regarding the quantity of light and the number of lamps. For instance, the city of Bialystok, a manufacturing town of 60,000 inhabitants and about 50 factories, is illuminated by 300 petroleum street lamps involving an annual expense of 2,900 rubles ($1,450). The city would now like to have an electric plant comprising 50 arc lights and 300 incandescent lamps, for which it is willing to pay 6,000 rubles annually, corresponding to about 6 kopeks (3 cents) per kilowatt hour, a price which would far less than cover the operating expenses. A big business is not to be expected from private customers, as neither citizen nor nobleman is inclined to consider innovations favorably, and the Jews, being the chief portion of the population, are very close and free from all desire for comfort and luxury when it may cost them anything.

One more unfavorable circumstance comes into question regarding the erection of electric light stations. The ground is extremely cheap and therefore is not considered in building up cities. Even in small towns the distances are very great in comparison to the estimated demand for light. In Bialystok it would be necessary to light 30 kilometers of streets, and the estimated demand for incandescent lamps would hardly reach 2,000.

The above mentioned conditions have to be considered in selecting a lighting system. First of all the plant must be very cheap and the cost of running must be a trifle; but as coal is cheap in Russia the cost of running may be considered as low. On the other hand, the simplicity in manipulation and safety in running must be insured because the labor to be had, though cheap, is hard to educate. This condition disfavors any attempt to comprise parallel aggregates of alternating current, which, however, providing the use of alternating currents is at all considered, cannot be avoided, owing to the great fluctuations in the demand for light, and in view of the necessity to save the possibility of enlarging the plant. On account of the great distances the alternating current seems to be preferable to the continuous current, while, on the contrary, it is advisable to avoid too high tensions because the novelty of the thing excites too much curiosity in a country where so little advancement in civilization exists, thus introducing danger.

The difference in the cost between operating with alternating and direct currents rests, in fact, only in their relative efficiencies. For direct currents it is apparent that aside from the smaller losses (no existing transformation, induction, impedance) the possibility of using accumulators affords great facility of operation, notwithstanding extremely great differences in consumption between day and night hours and between the night hours before and after midnight.

For reducing the cost of running, incandescent lamps should have preference over arc lights, because their renewal costs considerably less than the arc light carbons. In the cost of the plant the extension of the wiring is such an important item—principally on account of the high price of copper (generally over one ruble per kilogram)—that it is at first necessary to look for any possible reduction therein. It can be obtained apparently in the best way by the series system, which, of course, must be adapted to the circumstances described. As only medium tensions may be employed here, easily reached with either the alternating or continuous currents, both systems are equally applicable, and continuous current even preferable for higher tensions, being freer from danger than is the case with alternating current. But the series system is only applicable to street lighting, and the employment of continuous current presents the disadvantage that, besides the high tension machines being unapplicable to house illumination, there may be special arrangements for this purpose.

Notwithstanding, this system has found application. The city of Czestochowa, in Poland, has acquired of late a lighting plant consisting of 30 arc lamps. The plant cost 18,000 rubles, and is run by a contractor who receives 5,400 rubles annually. House illumination is, of course, not provided. If, however, outside of the public illumination a certain amount of private illumination should be attempted, and it is not desired to work with several installations of machines of various types, then the alternating current must be used. The high tension is employed in the streets in the series system and as primary current in suitably located transformer sub-stations, while the house illumination is supplied at normal tension from the secondary circuit of the transformer.

In order to comply with the requirements of cheapness, economy and easy manipulation the writer employs 3-phase currents and series of lamps connected in star-like system to a neutral circle wire. In this way only a minimum conductive material is necessary. Care should be taken to arrange overhead the conducting systems so that only wires of the same polarity are strung on one pole, reducing the danger of the high tension to a minimum, provided everything is well insulated from the earth.

This arrangement possesses several advantages. For instance, three series of lamps may be extinguished without any influence on the other lamps. If it is desired to extinguish the series independently of each other, it can easily be done by inserting inductive resistances. The latter may be arranged in the form of choking coils with adjustable magnetic resistance to make it possible for any desired number of lamps in one or more series to be extinguished or kept burning.

The region to be lighted is surrounded by a ring circuit which serves as a circuit of equalization and is connected at several points with the neutral pole of the generator. From the other poles of the generator the conductors radiate into the city, connecting the included series of lamps to the circle wire.

The system involves certainly all the difficulties which belong to the series system in general. In arc lighting it is relatively easy to overcome them, although series of arc lamps are not by far so generally employed in Europe as they are in America. Since the system of the Westinghouse Company led the way in this direction, numerous firms of the Continent have experimented with and perfected systems of such series with suitably constructed lamps and systems of distribution.

It is much worse with incandescent lamps in series, which would have the most chance for general introduction in Russia, on account of the above stated reasons. In this also the system of the Westinghouse Company has found great application, through the Helios Company, which illuminated the Nord-Ostsee Canal by this system. As is well known the system consists in connecting the incandescent lamps to choke coils in the shunt circuit. Through these coils the whole current passes when a lamp burns out, whereby, through the apparent resistance of the spool, such a drop in the potential occurs that the voltage for the other lamps remains the same.

A Polish engineer, Alex. Rothert, in the employ of the Frankfurt firm Electricitats Actien Gesellschaft, formerly Lahmeyer & Co., has recently suggested a system which seems in general to be superior to the choke coil system and which appears to be especially likely to find a favorable application under present circumstances. It is similar to the described system of the Westinghouse Company. The reaction coils in the Westinghouse system are simply replaced by single transformers (*Electrotechnische Zeitschrift*, 1896, No. 10). For regulation of the tension the transformers act as well as the coils, because their secondary circuits remain open when a lamp burns out and the whole line current then acts as magnetizing current in the primary with a reactive tension 90° behind it in phase. This tension composes a resultant with the sum of the primary tensions of the still active transformers which differs but very little from the whole original tension, whereby the regulation is effected in the way described by the inventor.

The efficiency of this system is, as compared with the choke coil system, a trifle smaller with the same weight of copper and iron, that is, at the same cost. The space occupied by coils in the former system has to contain both coils in the transformer, so that the density of current and the loss of current by heat must be greater. This, however, is not of so much importance in Russia. On the contrary, the advantage that the lamps can be reached while in operation is very great, the lamps being completely away from the high tension current and therefore the operation of the lamps is free from danger. It was stated above how much this has to be considered in Russia on account of the unskilled character of the only labor at hand. The advantages of this system, which permits of selecting any number of lamps from one series and any voltage, must, in conclusion, be pointed out. These two important conditions only influence the ratio of transformation, which is equal to the tension of the system divided by the number of lamps of one series and divided by the voltage of the lamps which according to circumstances may be one of those usually employed.

This system of distributing light is destined to find general application in Russia in view of the reduction of the first cost of the plant and by virtue of its simplicity in operation. At present it is under test by the above-named Company. It will probably help to bring about an understanding between the close and saving town authorities and the contractors who don't care to take big risks.

The Decimal System in Engineering Measurement.

Captain Henry Riall Sankey, Mem. Inst. of Civil Engineers (England), in discussing this subject, says:

Broadly speaking, the decimal system is used in engineering in this country whenever calculations other than mere checking have to be

made, or when very accurate dimensions have to be expressed; and in either case, in mechanical engineering, the decimals are generally those of the inch, its square, or its cube. The reason of this is fairly obvious. As regards calculations, decimals are, on the whole, far simpler than vulgar fractions, and they allow of the ready use of the slide rule or tables of logarithms.

It is true that occasionally simple vulgar fractions have to be dealt with, as, for instance, one-sixth in the case of the formula for the strength of a rectangular beam. In such cases the vulgar fraction would obviously be used; to convert to decimals would correspond to using a slide rule or a book of logarithms to multiply 6 by 5, or some such simple sum.

In the case of accurate dimensions in mechanical engineering, $\frac{1}{64}$ inch is far from being a sufficiently small dimension; hence the use of the terms bare and full; and as, for interchangeable work, such vague dimensions are very unsuitable, recourse is naturally had to the use of $\frac{1}{1000}$ inch and $\frac{1}{10000}$ inch. The writing down of accurate dimensions is also very cumbrous, even when they can be expressed by $\frac{1}{64}$ inch.

Compare, for instance, 11 inches + $\frac{1}{16}$ + $\frac{1}{32}$ + $\frac{1}{64}$ bare with its decimal equivalent 11.98 inches. No doubt the same dimensions may be more briefly expressed as $11\frac{63}{64}$ inches, but this form is not generally used in practice, and there are obvious reasons why this should be so.

It will be observed that the decimal expression has only been carried to the second place, and this is because the uncertainty in $\frac{1}{64}$ inch "bare" is of the order of $\frac{1}{100}$ inch. If the decimal expression is extended to the third place, an order of accuracy is reached, expressed by $\frac{1}{1024}$ inch on the binary scale, fractions which are not practically workable.

When dimensions of no special accuracy have to be stated, the natural tendency to successively divide the unit by two gains the upper hand. Notwithstanding this tendency and the prevailing custom, it can scarcely be doubted that it would be preferable to state all such dimensions in decimals of an inch.

If decimals of an inch are adopted, the system is still incomplete, owing to there being 12 inches to the foot, 3 feet to a yard, and so on.

It is here that the metric system has a great advantage; it is a decimal system throughout. As experience in such a matter has more value than mere theory, a statement of the results of introducing the metric system of linear measurements into the works of Messrs. Willans & Robinson may be of interest.

In the first place, it is desirable to say a few words about the class of work and method of manufacture carried out at the works in question. The Willans central valve engine and the Niclausse water tube boiler are manufactured each in certain definite standard sizes, and the parts required are made to gauge and template in large batches, and have to conform to fixed dimensions within specified limits of accuracy, in order that strict adherence to the interchangeable system may be maintained.

In the machine and examination of the parts, gauges and templates are used, as far as possible, to the exclusion of the measuring rule. Whether inches or millimeters are used is, therefore, not a matter of much importance.

At the marking-off table, the measuring rule is, of course, more used, and the question of convenience in the unit of measurement, and its divisions, is of greater importance; the parts are, however, dealt with in batches, and the convenience or otherwise of the unit of measurement, and its divisions, tells once only for each dimension for the whole batch.

The circumstances that led to the adoption of metric linear measurements are not of general interest, and for reasons which need not be entered into here they were only applied to the Niclausse boiler and to certain sizes of the engine; the earlier sizes being still made to drawings figured in feet and inches. Thus the two systems are concurrently at work in the same shop.

There would have been no advantage in re figuring these drawings with equivalent millimeters, and to make new parts to millimeters to interchange with old parts made to inches would be impossible without going to several places of decimals. The old gauges and templates were marked with the millimeter equivalent to the third place of decimals, but this was merely to accustom the men to sizes expressed in the new system. It may be mentioned that the men were supplied with rules marked with millimeters on one side and inches on the other.

The expense involved consisted principally in providing a complete set of gauges. New templates and jigs had also to be made, but only a portion of their cost is properly chargeable to the introduction of the new unit, as the greater number of them would have been required in any case.

The only difficulty met with has been in connection with the screw threads. Hitherto, the ordinary Whitworth and gas threads have been retained; but, for reasons connected with the manufacture of the engines abroad, the body of the bolt or stud is turned larger than usual, the excess being 0.3 millimeter for $\frac{1}{4}$-inch Whitworth, and 2 millimeters for $1\frac{1}{2}$-inch Whitworth. Intermediate sizes are in proportion, all being brought up to even millimeters. The bored holes are then able to take the corresponding screw cut to the standard used by the French makers of the engine, who use the thread of the Société d'Encouragement, which is slightly larger than the Whitworth, and which, it is stated, promises to become universal in France; it is now adopted by the French navy and railways.

The metric dimensions were introduced in May, 1893, and, after four years' working, the following is the result:

No difficulty has been experienced in getting draughtsmen to use the new measures. No serious mistakes have been traceable to the change, and very few minor ones. The draughtsmen are practically unanimous in favor of metric measures, finding it easier to design, to check and to read millimeter drawings. Taking all fractions into account, little more than half the number of figures formerly used are now required to express a dimension. An average case would be 3 feet $1\frac{3}{4}$ inches, which, on a millimeter drawing, would be figured 949; and an extreme though possible case is 3 feet $1\frac{3}{32}$ + $\frac{1}{64}$-inch bare, which becomes 942.4.

The need to use decimals of a millimeter is very infrequent, but in the case of inches the use of fractions is, of course, the rule. A cylinder, for example, might be figured 2 feet 6 inches on an inch drawing, and 770 on a millimeter drawing; the piston body must have a certain clearance, say $\frac{1}{32}$ in one case, or 1 millimeter in the other, in which case it must be figured 2 feet $5\frac{1}{16}$-inch on the inch drawing; whereas, on the millimeter drawing, the dimensions becomes simply 768, and the use of fractions is wholly avoided.

The proportions between dimensions are more readily appreciated when expressed in millimeters; thus the ratio between 27 millimeters and 49 millimeters is much more easily apprehended than between $1\frac{1}{16}$-inch and $1\frac{15}{16}$-inch.

A point of some importance is that the ordinary foot and inch ticks or marks are not required, and with them disappears the possibility of having 2 inches added to each 10 inches, or deducted from each foot in a dimension. A case of this kind occurred in which two 13 inch flanges intended to come together were shown on different drawings; in one of them a tick was introduced after the one, and that flange was made 1 foot 3 inches.

With millimeters a cypher might possibly be put in or omitted; but a dimension ten times too big or too small would at once be noticed as absurd.

In the drawings, scales 1, $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$, and occasionally of $\frac{1}{25}$, $\frac{1}{50}$, are used. It is found that this number of scales is amply sufficient.

No mistakes have been made in marking off work to millimeters. The men preferred the old system at first, the new figures conveying little idea of size; but they are now much in favor of the millimeter, and find drawings so figured easier to read. The shop where the difficulties of the change would be most felt is that in which the tools and gauges are made; the foreman says that it was a little awkward at the outset—for about two days.

In the works manager's opinion, the metric system would prove even more advantageous in shops where measurements are taken from the rule than where gauges are used. He considers it easier to teach men the use of the rule with the metric than with English measures.

Should Generating Plant be Mounted on Springs?

Having asked the question, Mr. James Swinbourne, the noted English engineer, had the following to say in answer thereto:

This is really part of a larger question: Should moving machinery be mounted on springs? The question concerns both the health of the moving machinery, and of the people who may be moved by it. In central stations and in passenger steamers, the shaking caused by machinery is most serious; in flour mills, for example, it is rather a question concerning the gear itself.

If we consider, say, a direct acting pump in space, it is a system that of course cannot move its center of gravity as a whole. If, then, its pistons and plunger move in one direction, the rest must move in another direction, the distance depending on their masses. Any imperfectly balanced machinery must therefore move its bedplate if freely suspended. A perfectly balanced engine is thus an engine whose center of gravity never varies relatively to its bedplate. This definition is

really too small, because a moving system, such, for instance, as two cranks at 120° on opposite ends of a shaft, do not change their center of gravity, but give the bedplate a rocking but non-translational movement. A gas engine with a flywheel, similarly, tends to rotate its bedplate at each impulse, round an axis parallel to that of the shaft. A balanced engine is therefore really one which does not move its bedplate if freely suspended. Such an engine is practically never realized.

When an engineer sees an engine bedplate moving, his first instinct is to bolt it down; it then moves a little less, but still moves, and he has a sort of feeling it must shake itself to pieces if allowed to move. Bolting down an engine to a bed of concrete is merely increasing the size of its effective bedplate, but the whole bedplate, including the concrete, must now be moved. It rests on the earth, moves slightly, and communicates vibration to neighbors who are longing to be compensated for disturbance.

Sometimes the concrete bedplate is isolated by mounting it on felt; that means that the larger bedplate is mounted on rather imperfect springs.

A rather striking case is that of church bells. Bells are very much out of balance, and the bedplates are mere cages of timber; so the bedplates would tend to move a good deal. The bell people do not like to see it move, so they wedge it to the steeple, and the result is a cracked steeple. The consequence is, that you often hear that such a church has a very fine peal of bells, but they cannot be used, as the steeple will not stand it. Though this may be a relief to people whose ears are in tune, it might be cheaper not to make bells, than to make them and hang them so that they cannot be used.

The question is, if the bedplate of an engine wants to move, why should it not have free play? As far as the engine goes, a little thought will show that all its parts are subjected to smaller stresses if the bedplate is free to move. An engine will therefore wear longer if it is allowed to move its bedplate. As to the foundations, if the bedplate is allowed to move, no foundations to speak of are needed; and there is no vibration communicated to the ground.

The writer has tried this arrangement on a small scale. There is a small dynamotor on one of the top floors of Mr. Crookes' house which is very much out of balance, and rendered the house uninhabitable at first. It is now on springs and makes no noise. There is also a dynamotor for electrolytic work in the writer's laboratory. It has no springs, and no one has any inkling of a chance of complaining.

In passenger steamers the throb of the engine is extremely unpleasant; in fact, many people would rather go by a slower boat than travel 21 knots and be at the same time shaken 42 more knots by his pedometer. Mounting marine engines on springs seems rather a bold suggestion, and perhaps we ought not to begin there. The moving systems are so heavy in proportion to the fixed (or "attached" is the better word) that the marine engine is a particularly difficult case.

The idea of mounting engines and dynamos on springs was mooted by the writer in *Industries* in 1892. The editor, in addition to being a sound engineer, is a man of caution, so the communication came out as an anonymous letter. Mr. W. W. Beaumont has, however, done a great deal of real work on the subject, especially in connection with flour mills. He has introduced his "vibrometer" principle. This principle is simple. "If gear wants to wobble, let it wobble." The idea seems sound; the discussion will perhaps throw new lights on it.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. J. H. Enright, Superintendent of the Nevada (Mo.) Light Company, has been quite a busy man this season, for since May 1st he has directed the reconstruction of that Company's manufacturing plant. On May 1st the contracts for the apparatus were awarded, and on June 6th the new plant was producing and sending out gas. The betterments included 3 benches of 5's, coil condensers, a washer-scrubber, 4 purifying boxes and a Root's exhauster. The holders were also carefully overhauled. Mr. Enright is now engaged in restoring the main system to a normal condition, that the Nevada plant may in all respects be considered as in good physical condition.

Mr. George M. Myers, the General Manager of the Nevada Light Company, has also been persistently active in well-directed attempts to increase the output of the Company on fuel account. To further this growth, on June 19th he advertised the fact in the local newspapers, that the Company would sell gas ranges and stoves at cost, and connect same free of charge to any purchaser who resided in a street in which the Company had mains, the only provision being that the stove was to be located on the ground floor of the residents' premises. The Company carries a well-assorted line of ranges, stoves and other gas cooking appliances in its offices.

The Directors of the San Francisco Gas and Electric Company have declared a dividend for June of 50 cents per share, payable on demand. The understanding is that the Company has put its shares on a permanent dividend basis of 6 per cent. per annum.

Mr. Thomas D. Miller, of Dallas, Texas, writing under date of the 8th inst., says: "A move is on foot to bring about, at the next meeting (to be held in Laredo) of the Texas Gas and Electric Light Association, a meeting of the Texas Electric Street Railway Association, the Mexican lighting men and the Mexican street railway men. The Mexican government has shown considerable interest in the matter, and negotiations are now pending looking to the end above noted. Should they succeed in the proposed plan, this will be the most important meeting of the named allied interests ever held in the southwest, and an interesting and instructive exhibit can be confidently looked for, as the supply men will undoubtedly have an opportunity to reach a larger number of users of their wares from a larger territory than has ever been before them in this section. It is unfortunate, though, for the gas interests that Laredo has no gas plant. Of course, no plan has yet been formulated, but it is very probable that a satisfactory programme can be arranged for these meetings.

The Directors of the Charleston (S. C.) Gas Light Company have declared a dividend of 75 cents per share, payable on demand.

At the annual meeting of the Universal Gas Company, of Chicago, the following Directors were elected: Clarence Buckingham, James C. Hutchins, Joseph Leiter, William Dickenson and E. H. Brush.

Mr. Geo. P. Spittal, the popular and energetic Secretary-Treasurer of the Ottawa (Can.) Gas Company, is no longer a single man, Miss Rose Holland having agreed to share his fortunes on the afternoon of the 7th inst.

At the annual meeting of the Norristown (Pa.) Gas Company no change was made in the executive management.

At the annual meeting of the Milwaukee (Wis.) Gas Light Company the officers chosen were: Directors, Emerson McMillin, F. G. Bigelow, W. Becker, John P. Murphy, A. E. Smith, H. C. Payne, S. M. Green, B. M. Weil and E. G. Cowdery; President, E. McMillin; First Vice-President, B. M. Weil; Second Vice-President, S. M. Green; Secretary and Treasurer, S. J. Glass; General Manager, E. G. Cowdery.

We understand that a controlling interest in the Battle Creek (Mich.) Gas Light Company has been secured by Mr. Stephen S. Hulbert, who is said to represent Eastern capitalists.

Inspector Meeds reports that during June the average lighting value (the result of 26 separate gas tests) of the gas supplied by the Minneapolis (Minn.) Gas Light Company was 23.57 candles. The average consumption of gas in the public lamps was 6.01 cubic feet; the average pressure (maximum) on the street mains was 2.22 inches, the minimum pressure being 1.44 inches. Five meters were tested on complaint of consumers, of which none was condemned.

Some time ago we reported that the plant and franchises of the Geneva (N. Y.) Gas Light Company had been purchased by an Eastern syndicate. The purchasers have recently filed articles incorporating the Geneva Gas Company, "to manufacture and supply gas and electricity in Geneva, Ontario county, N. Y." The capital has been put at $100,000, and the Directors are: Henry P. Cox, Augustus R. Wright, Ammi Whitney, George F. Duncan and Edward B. Winslow, of Portland, Me.; and Oliver H. Wright and Homer Wright, of Geneva.

We understand that the proprietors of the Hornellsville and Canisteo (N.Y.) fuel gas concern have placed the full management of its affairs in the hands of Mr. George W. Beck, who will be remembered in the West from his connection with the Alton (Ills.) Gas and Electric Light Company.

The 8-ton road roller employed by the authorities of Newburgh, N. Y., to finish the macadam surfacing of many of the roadways, has played havoc with the mains and services of the Consumers Gas Company of that city.

THE water gas set recently contracted for by the Westerly (R. I.) Gas and Electric Light Company is now in working order. The Company has reduced the gross selling rate to $1.75 per 1,000 cubic feet—a concession of 75 cents per 1,000. Prompt payment of bills (on or before the 10th of the month) entitles the consumer to the following discount rates: Monthly bills of $5 and under, 5 per cent.; $5 to $20, 10 per cent.; over $20, 15 per cent. Bills that are rendered quarterly will be computed in three parts in adjusting the rebate.

ABOUT a fortnight ago the Committee on Claims, of the Buffalo (N. Y.) Board of Aldermen, was confronted by a claim quite out of the usual line. It was put in by Mrs. Gussie Goldin, who owned and maintained a cloak and millinery shop in the store on the premises No. 629 William street, and was based on carelessness of the employees of the Water Bureau. On January 5, 1897, the Bureau wished to make some repairs to the main which supplied the houses and stores on William street, and sent a man to shut the water off. The man who visited the Goldin shop turned off the gas instead of the water, and when the time came to light up the clerks were unable to do so. It was not until the next morning that the mistake was corrected, the shop meanwhile remaining closed. Mrs. Goldin asks for $100 damages as a result of the Bureau's carelessness, and the petition was referred to the Corporation Counsel for an opinion. During the debate that followed the presentation of the claim, several Aldermen expressed the opinion that the Goldin claim was a valid one, the only question for consideration being an adjustment of the sum that should be awarded.

AT an election held by the taxpayers of Tyrone, Pa., it was determined, by a fair majority of the votes cast, to clothe the authorities with power to take over the plants of the Tyrone Gas and Water Company for operation on public account. The ballot also specified that the sum of $108,000 should be borrowed on the credit of the borough for payment of the plants to be taken over. On the 8th inst. Messrs. A. A. Stevens, D. G. Hills, W. Walton and Joshua Walton, representing the Gas and Water Company, filed a protest with the proper legal authority, alleging that the ordinance providing for the election was illegal; that the special election was not legally advertised; that the amount to be borrowed would encumber the borough beyond the lawful limit, and that the election was illegal. Judge Bell heard the arguments over the case on the 9th inst., and reserved decision.

SOME time ago we reported the sale of the Athens (Ga.) gas works, the purchaser being Mr. J. W. Cowdery. Mr. Cowdery in turn sold the works to Mr. John B. Cocke, who, if we mistake not, has been for some time in the employment of the United Gas Improvement Company.

AT the annual meeting of the shareholders of the Bridgeton (N. J.) Gas Light Company, held at noon of the 8th inst, the following Directors were elected: Chester J. Buck, H. W. Elmer, Daniel Elmer, Daniel Bacon and Geo. H. Whipple. In accordance with the practice that has prevailed in the management of the Company for some years, which practice has been to reduce the selling rate whenever the income from sales exceeded an amount over a fair dividend on the capital stock, Superintendent Harding was authorized to publish in the local papers the following announcement: "It has been the policy of the Directorship of the Bridgeton Gas Light Company, for years past, as the consumption of gas increased, and consequently lowering the cost of production, to lower the price to its consumers. In accordance therewith the price of gas, from July 1st, 1897, till further notice, will be $1.25 per 1,000 cubic feet."

MR. D. BRADFORD BARTLETT, for many years employed in the office division of the staff of the Lowell (Mass.) Gas Light Company, died at his home, on Willow street, that city, on the morning of the 11th inst. Deceased, who was in his 74th year, was a son of the late Dr. Josiah Bartlett, a prominent physician of Charlestown, Mass.

THE semi-annual dividend of the Chelsea (Mass.) Gas Light Company, amounting to 2½ per cent., has been payable since the 15th inst.

THE Board of Review, department of assessment, Lafayette, Ind., has returned the valuation of the property of the Lafayette Gas Company for purposes of taxation at $225,000, as against the heretofore valuation of $184,000. The Company, having good ground for such action, will contest the assessment.

A CORRESPONDENT at Omaha, Neb., forwards the following clipping from the Omaha *World*, dated the 7th inst.: "Mayor Ensor has signed the gas franchise ordinance for South Omaha. This means that if the ordinance is accepted by the South Omaha Gas Company—and there is every assurance that it will be—within 18 months gas mains will be extended from the mains now ending at A street, down to Q street, branching off on N street. The price is to be $1.60 per 1,000 cubic feet, with 10 cents off for prompt payment of bills—within 10 days from presentation. When the average daily consumption reaches 100,000 cubic feet, a further concession of 10 cents per 1,000 is to rule.

THE Chicago *Inter-Ocean*, of the 11th inst., has this to say over the late Mr. Andrew E. Smythe: "Mr. Andrew E. Smythe, one of the best known gas company promoters in the West, died Friday afternoon (July 9th) at his home, No. 206 Bowen avenue, after a short illness. He was a promoter of the Universal Gas Company, which secured an ordinance under the administration of Mayor John P. Hopkins, and he also figured in the famous Bacon compressed air ordinance passed by the Chicago Council a few years ago. Mr. Smythe, who was known as 'Bony Back,' was a well known character in New York and Philadelphia a few years ago. He early evinced an inclination for speculation and company promoting, but many of his first ventures were unsuccessful. Early in the '70's he married a wealthy young lady, a step which brought about a change in his business fortunes. He started the Philadelphia *Evening Herald*, with which he was connected until 1878, when he was brought into unpleasant notoriety by the circumstances attending the arrest and conviction of John S. Morton, President of the Market Street Railway Company, of Philadelphia. Since coming to Chicago, Mr. Smythe was interested in the development of the Mutual Fuel Gas Company, of Hyde Park, Chicago."

THE New York *Sun*, of the 14th inst., had this to say respecting the late Mr. Columbus R. Cummings, who died on the evening of the 13th inst.: "He was born at Canton, N. Y., in 1836. In his youth he taught school, was a clerk in a store at Ogdensburgh, N.Y., and subsequently settled in Pekin, Ills., where he gained a foothold as a capitalist in manufacturing harvesting machinery. About 1877 he removed to Chicago, where he engaged in several lines of business, all of which resulted profitably. He was President of the Union National Bank, and was a large stockholder in several other financial institutions. He owned most of the stock in the Consumers Gas Company, of Chicago, and was interested in important railroad syndicates, being President of the Lake Erie and Western Railroad, and of the Peoria and Evansville Railroad."

WE are indebted to Mr. Walter R. Addicks, of Boston, Mass., for a copy of the following report, submitted to the Guild of Gas Managers by its special committee, appointed some time ago to determine upon a standard test gate:

"*To the Guild of Gas Managers:* Your Committee appointed to report on the question of a gas gate, for use as a test gate when desirable, beg leave to make the following suggestions and recommendations:

"*First.*—The sizes that should be provided for are 3, 4, 6, 8, 10 and 12 inches in diameter.

"*Second.*—The body of the valve may be of any usual style, with preferably some design of white metal seat.

"*Third.*—The test pipes should be cored in a projecting portion of the body of the valve immediately behind the bell. To permit of the test pipes entering this channel the flange of the valve, as well as that of the bonnet, should be swelled out, so as not to weaken the flanges where the test pipes pass through them.

"*Fourth.*—Both the flanges above mentioned should be left blank, in case the valve is not intended for test purposes; the one pattern will thus answer both purposes.

"*Fifth.*—The diameter of the test pipes should be a uniform size. Your Committee recommend ¾ inch as the diameter of the test pipes.

"*Sixth.*—The inside diameter and length of the bell for lead joints to be those recommended by the Society of Gas Lighting.

"*Seventh.*—For cement joints, pipe 3 inches to 12 inches, bells should be 5 inches long. The diameter of the bells should be the diameter of the pipe, plus 2¼ inches, for 3, 4, 6 and 8 inches; for 10 and 12 inches, add one-quarter inch. All of which is submitted for discussion by your Committee.

"W. R. ADDICKS, Chairman.
"C. F. PRICHARD,
"W. A. LEARNED."

THE AMERICAN GAS LIGHT JOURNAL

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MONDAY, JULY 19, 1897.

Causes of Decay in Mine Timber.

A writer in the *Colliery Engineer*, in dealing with this subject, says it is a fact of experience that cannot be questioned that mine timber is more subject to decay than timber exposed to all the vicissitudes of the weather on the surface; and there are more causes than one that promote this waste, but the most rapid and destructive agent in affecting it is a parasite called the cotton mold fungus. This living organism finds a genial environment in a warm moist atmosphere where timber abounds. It is, however, remarkable that it propagates most rapidly on the softer varieties of the woods of the conifers or fir trees, and it is evident that moisture as well as warm air are conditions necessary to its life and growth. It is a weird sight when you enter a mine and see the timber completely clothed with this fungus as though it had on a covering of cotton wool, but there the interest ceases, for we know that wherever that fungus is found the timber is destroyed. The mode of the propagation of the fungus is through the medium of air currents, as the germs are carried along by the wind and wherever they alight on timber they insert their tentacles in its skin and begin at once to fructify and multiply their germs that set up a vito-chemical action that reduces the wood to rottenness.

To prevent the destruction of the timber the mining engineer has to be constantly on the alert so that he may be able to establish antiseptic conditions that will prevent the ravages due to the vito-chemical action of the cotton-mold fungus, for the loss to mining is not so much that of the timber, though this is bad enough, nor is it the loss due to the additional labor required for a constant restoration of the timber, but the greatest loss of all arises from the falling of the roof, the crushing of the coal and the loss of output as a consequence of the failing of the roof supports and the stoppage of work resulting from that cause.

To prevent the deposition of the germs of the fungus in the skin of the wood, the first idea that presents itself to the mind of the novice in these matters is to cover the skin of the timber with some kind of a paint; and as coal tar seems the cheapest and most likely oil for the purpose, it has been tried with only very partial success, for the tar excludes moisture and promotes dryness, and the result is, after a while the timber cracks; and as soon as this occurs the germs of the fungus insert themselves in these little fissures, and the consequent destruction of the timber at once begins. Again, coating timber with a wash of quicklime has been tried with no better results than that of coal tar, and it may therefore be said that coating the timber with preparations of any kind has so far proved a practical failure. It has been observed that when timber is long immersed in salt water its preservation is considerably promoted, and on the basis of this fact it was thought that if mine timber were soaked in salt brine it would be able to resist the vito-chemical action of the cotton-mold fungus. This has also proved a failure, for it is found that after a while the fungus begins to germinate in this timber and its destruction is just as complete as the timber that has not been so treated. It is true, however, that coating the timber and salting the timber are preservatives for a while, but afterwards the destruction goes on just the same as though no attempt had been made to protect it.

Saturating timbers with sulphate of iron and sulphate of copper has been tried, but the result of the test has in this, as in other cases, been a practical failure, for it was found that these solutions only enter the outer shell of the wood, where their farther ingress is arrested, and the prevention of the inflow seems to arise in this way: Watery solutions of iron or copper cause an expansion of the vesicles in the wood that closes up their interstices; attempts have been made to saturate timber by a mode of proceeding similar to that followed in creosoting wood, by first exhausting the air and afterwards injecting the fluid at a high pressure, but they failed.

Hitherto the only successful method that has been found to preserve mine timber is that of creosoting it; and this is done as has been noticed in reference to the trials that were made with the sulphates, by first having the timber placed in a tank from which the air is exhausted, and the result is the gases lodged in the vesicles of the wood are by this process all extracted, and when this has been done creosote oil is pumped into the tank at a pressure above that of the atmosphere, when the oil enters freely and saturates the wood to its core. The wood is now impervious to water, and is not only free from the tendency to rottenness through atmospheric changes, but is no longer subject to the vito-chemical action of the cotton-mold fungus.

The durability of creosoted wood is remarkable, for timber thus treated has after 20 years' exposure to wetness and dryness been found at the end of that time in practically good condition. It is true that the expense of the process debars the general use of timber so treated, yet nevertheless the facts of the results obtained from it ought to be known.

The writer has seen timber discovered in old workings, where it has been kept perfectly dry for a period of 30 years, still in good condition, and yet this timber was not creosoted, nor was it subject to the ravages of the cotton-mold fungus. It is clear, then, that this parasite only flourishes under conditions favorable to its growth, and further than that, the decay of timber is the result of the operation of destructive agencies that require to be known and understood.

The Market for Gas Securities.

The "prominent director in a large city gas company" was very busy last week denying that any scheme for merging any or all of the various city and suburban gas companies into a community of interest was underway. Meanwhile some notable advances have been made in gas share quotations, East River common, for instance, having sold at 90 or a trifle better; Equitable has advanced to 228 bid; Consol. idated sold at 169½—a record for it; and all other city gas shares show marked firmness. The formation, too, of a Company north of the Harlem river (to be known as the Central Union Gas Company), with a capital of $3,500,000, of course, means nothing (?) The real fact is that the scheme for consolidation is to all intents and purposes planned—in fact, it was planned long ago—and is very close to consummation. Our advice is to buy Consolidated, Equitable or Mutual at figures even well above current quotations; nor would it be impolitic to purchase East River common at the market. The general situation, which is shown in our quotations, proves the confidence that investors have in the gas trade.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks,
35 WALL ST., NEW YORK CITY.
JULY 19.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	169	170
Central	500,000	50	195	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	228	230
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	242	246
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	85	
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	88⅛	89
Preferred	2,000,000	100	113⅛	114
Bonds 1st 5's	3,500,000	1,000	112	115
" 1st Con. 5's	1,500,000	..	106	107⅛
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	.
Standard	5,000,000	100	110	111
Preferred	5,000,000	100	118	121
Bonds, 1st Mortgage, 5's	1,500,000	1,000	113	116
Yonkers	299,650	50	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	110¾	111
" " Bonds (5's)	15,000,000	1,000	112¾	113
Bay State	15,000,000	50	12	13
" Income Bonds	2,000,000	1,000	..	35
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	90	92
2d " " "	3,000,000	1,000	74	75
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	94¾	95
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	104	104¼

Columbus	1,069,000	..	78	80x
1st Mortgage	1,085,000	..	..	96
Consumers. Jersey City	2,000,000	100	78	77
" Bonds	600,090	1,000	101½	103
Cincinnati G. & C. Co	8,500,000	100	201½	202
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	57	58
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	.	22	..
" Con. Bonds	4,312,000	..	73½	74
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	79	82
" Bonds	2,000,000	..	92	94
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	150	153
" Bonds, 6's	2,650,000	..	107	109
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	85	87
Bonds	1,000,000	1,000	92	94
Louisville	2,370,000	50	.	..
Laclede, St. Louis	7,500,000	100	27¾	28
Preferred	2,500,000	100	80	82½
Bonds	9,084,400	1,000	100	100½
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co	1,000,000	..	142	..
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	94	94½
St. Paul Gas Light Co	1,500,000	100	79	81
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	70	72
Bonds, 5's	3,556,000	.	98	100
Wilmington, Del	550,000	50	200	202

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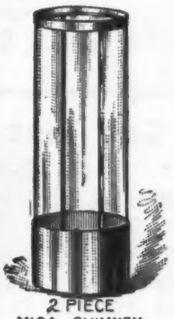

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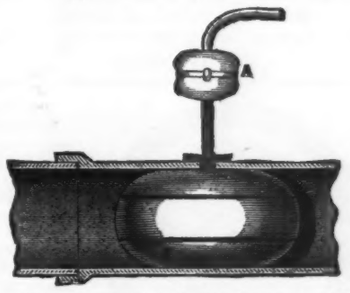

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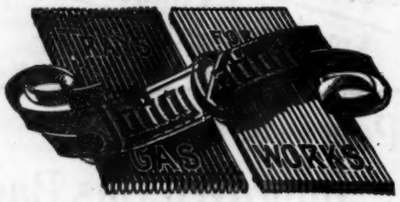

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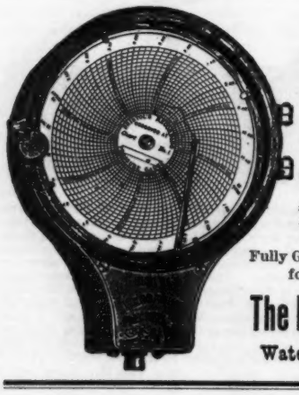

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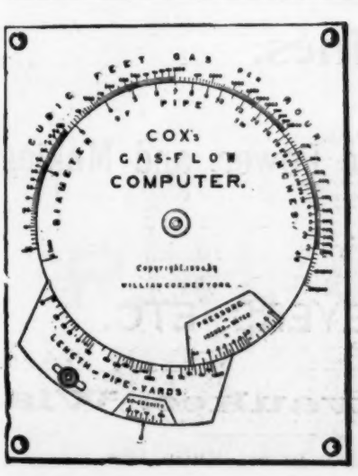

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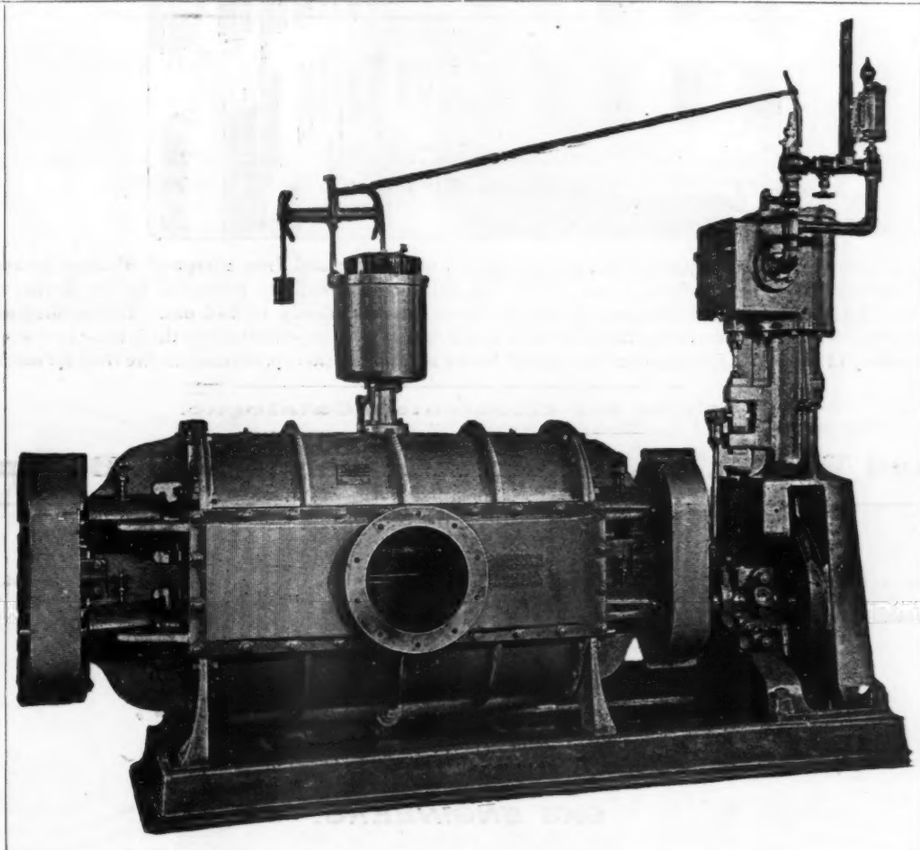

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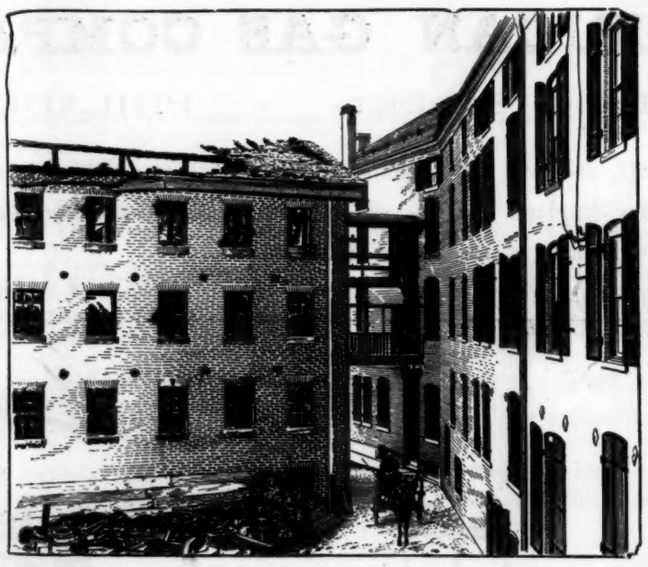

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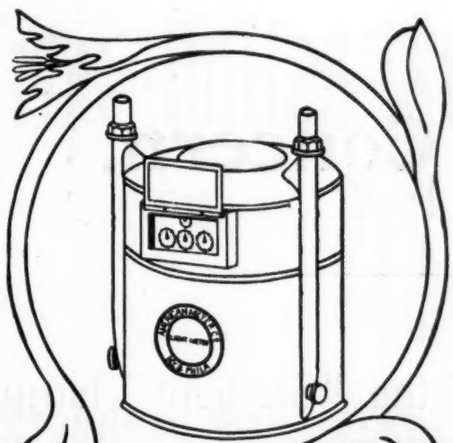

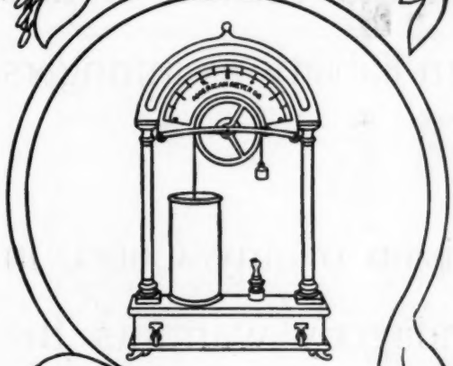

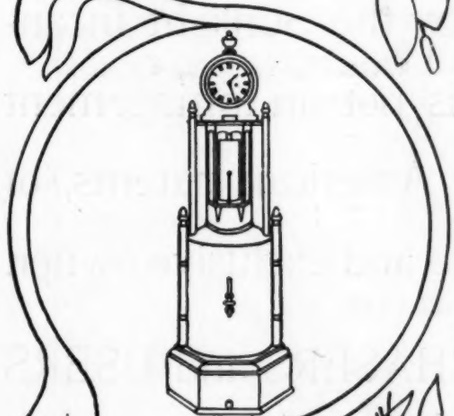

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NEW YORK AND PHILADELPHIA,
CHICAGO, ST. LOUIS,
SAN FRANCISCO.

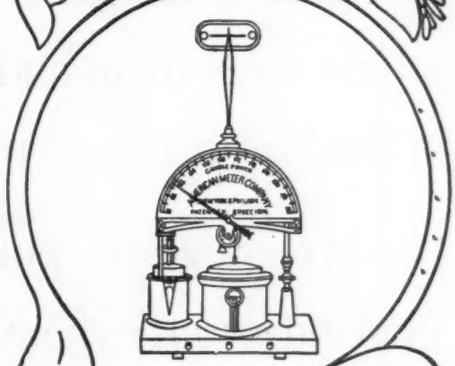
PUBLIC LIGHTING TABLE.

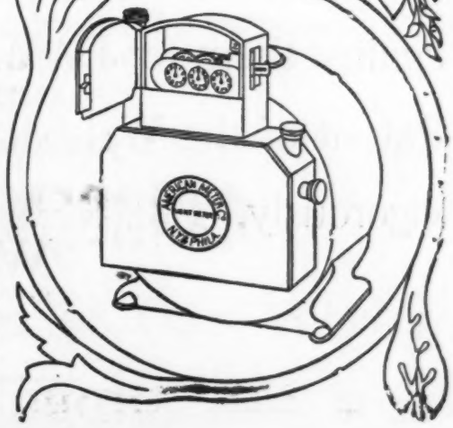
AUGUST, 1897.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sun.	1	7.40 PM	4.00 AM	7.10	3.30
Mon.	2	7.40	4.00	7.10	3.30
Tue.	3	8.30	4.00	7.10	3.30
Wed.	4	9.00	4.00	7.10	3.30
Thu.	5	9.40 FQ	4.00	7.10	3 30
Fri.	6	10.30	4.00	7.10	3.45
Sat.	7	11.20	4.00	7.10	3.45
Sun.	8	12.20 AM	4.10	7.10	3.45
Mon.	9	1.40	4.10	7.10	3.45
Tue.	10	2.50	4.10	7.10	3.45
Wed.	11	No L.	No L.	7.10	3.45
Thu.	12	No L. FM	No L.	7.10	3.45
Fri.	13	No L.	No L.	6.55	4.00
Sat.	14	7.30 PM	8.50 PM	6.55	4.00
Sun.	15	7.20	9.10	6.55	4.00
Mon.	16	7.20	9.40	6.55	4.00
Tue.	17	7.20	10.00	6.55	4.00
Wed.	18	7.20	10.30	6.55	4.00
Thu.	19	7.20 LQ	11.00	6.55	4.00
Fri.	20	7.20	11.40	6.45	4.10
Sat.	21	7.20	12.30 AM	6.45	4.10
Sun.	22	7.10	1.20	6.45	4.10
Mon.	23	7.10	2.20	6.45	4.10
Tue.	24	7.10	4.20	6.45	4.10
Wed.	25	7.10	4.20	6.45	4.10
Thu.	26	7.10	4.20	6.45	4.10
Fri.	27	7.10 NM	4.20	6.30	4.20
Sat.	28	7.10	4.20	6.30	4.20
Sun.	29	7.00	4.30	6.30	4.20
Mon.	30	7.00	4.30	6.30	4.20
Tue.	31	7.00	4.30	6.30	4.20

TOTAL HOURS LIGHTING DURING 1897.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	233.00	January	423.20
February	187.20	February	355.25
March	202.00	March	355.35
April	170.40	April	298.50
May	163.00	May	264.50
June	140.40	June	234.25
July	151.40	July	243.45
August	167.30	August	280.25
September	174.40	September	321.15
October	200.00	October	374.30
November	205.20	November	401.40
December	220.10	December	433.45
Total, yr.	2216.00	Total, yr.	3987.45





To Whom It May Concern.

WE have learned that the makers of the "Sunlight" lamp assert that there has been a decision in the English Courts which saves them and their customers from liability as infringers of the Welsbach patents.

We assure the public there is no decision of any Court, in England or elsewhere, that directly or indirectly warrants the statement or inference that the lamp sold by the Sunlight Incandescent Gas Lamp Company of America is not an infringement of the Welsbach Light as made under the American patents, of which the Welsbach Light Company is sole and exclusive owner.

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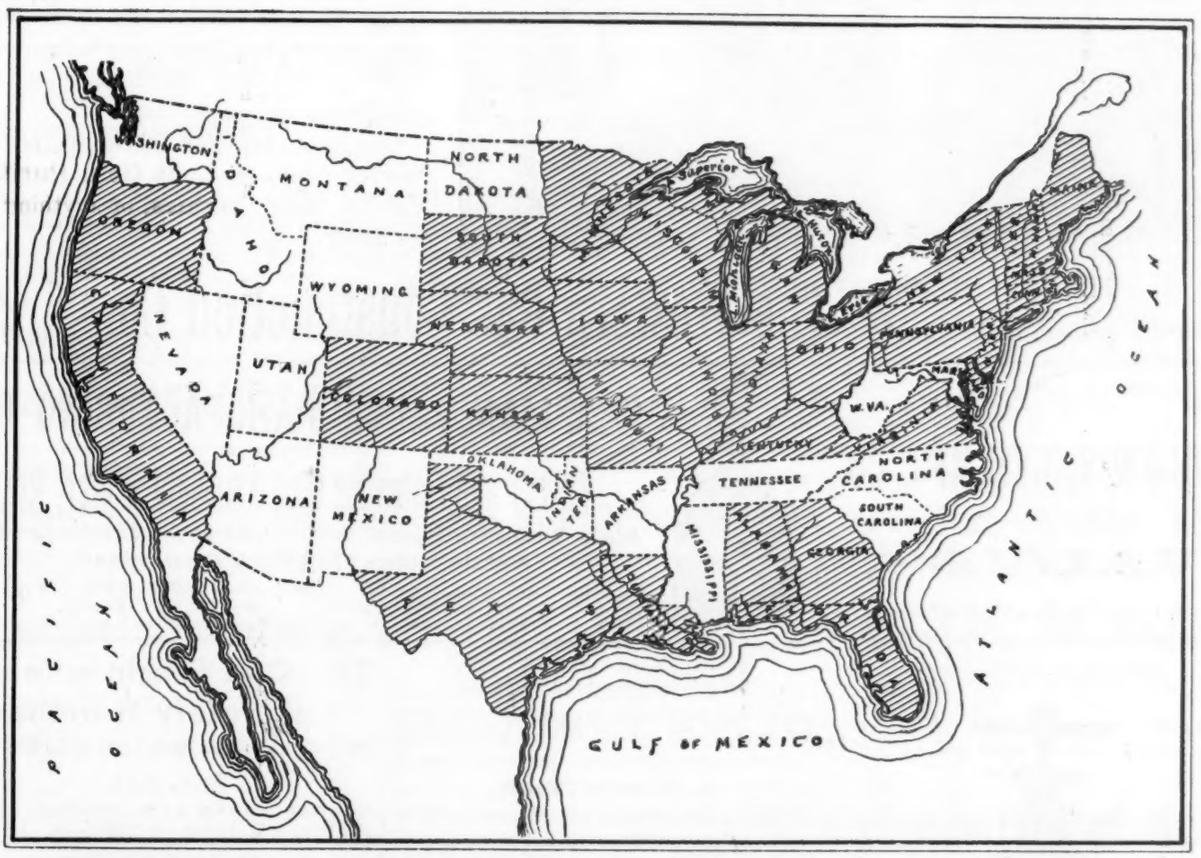

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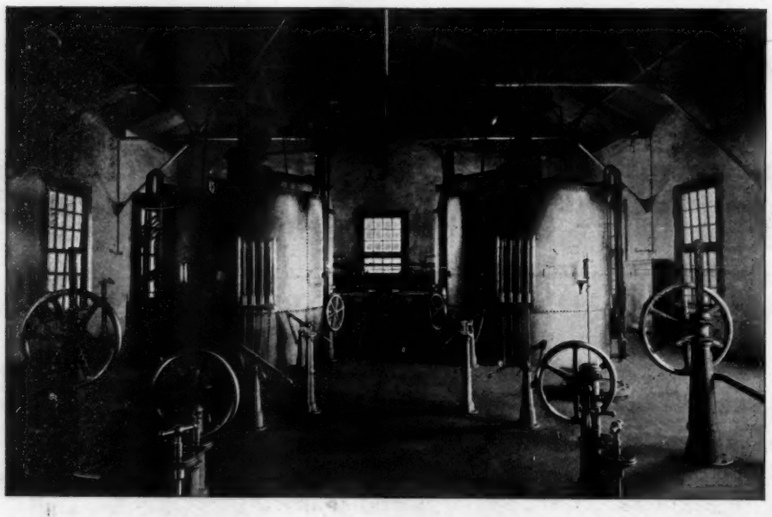

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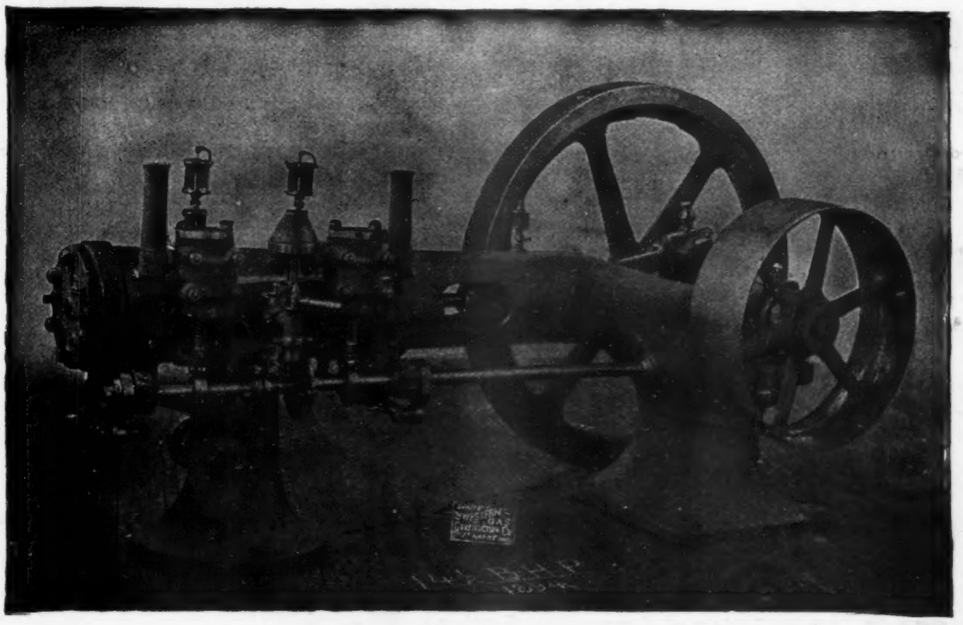

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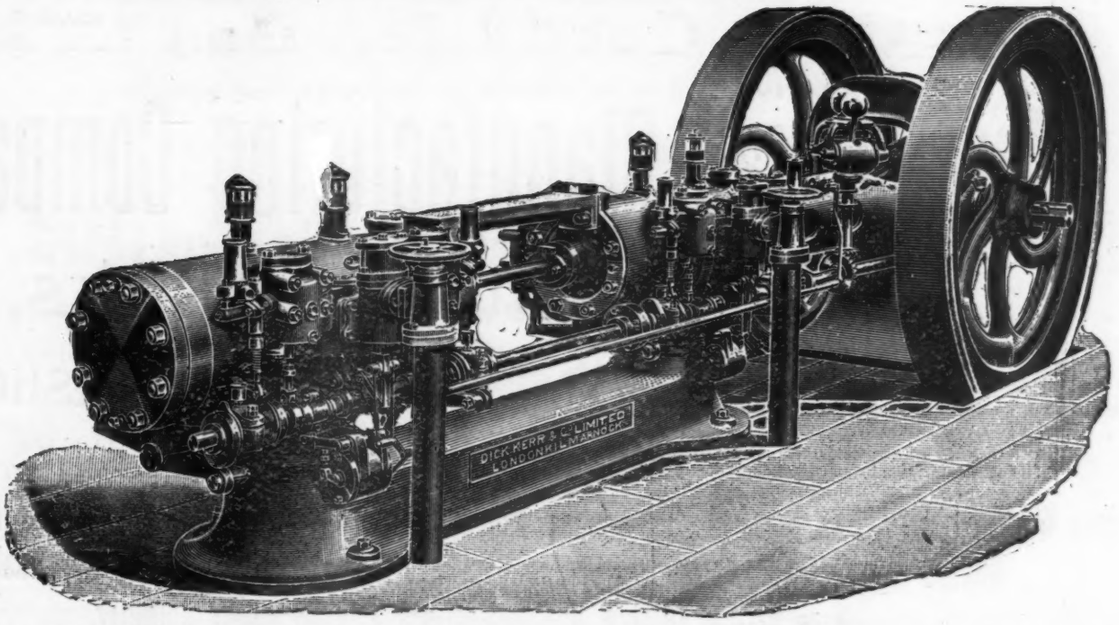

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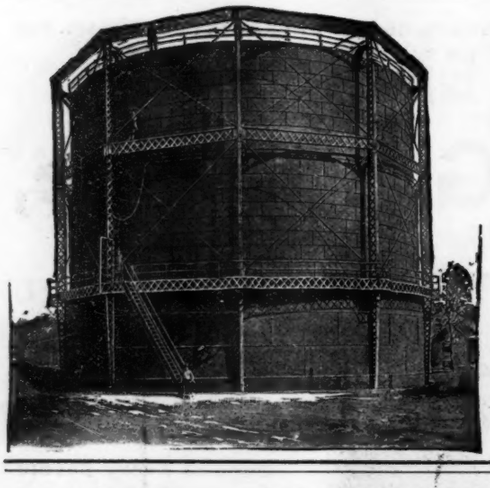

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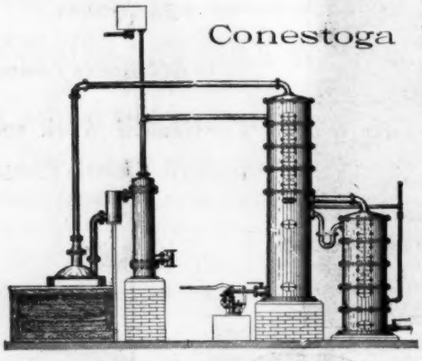

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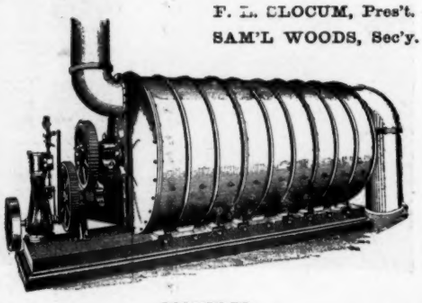

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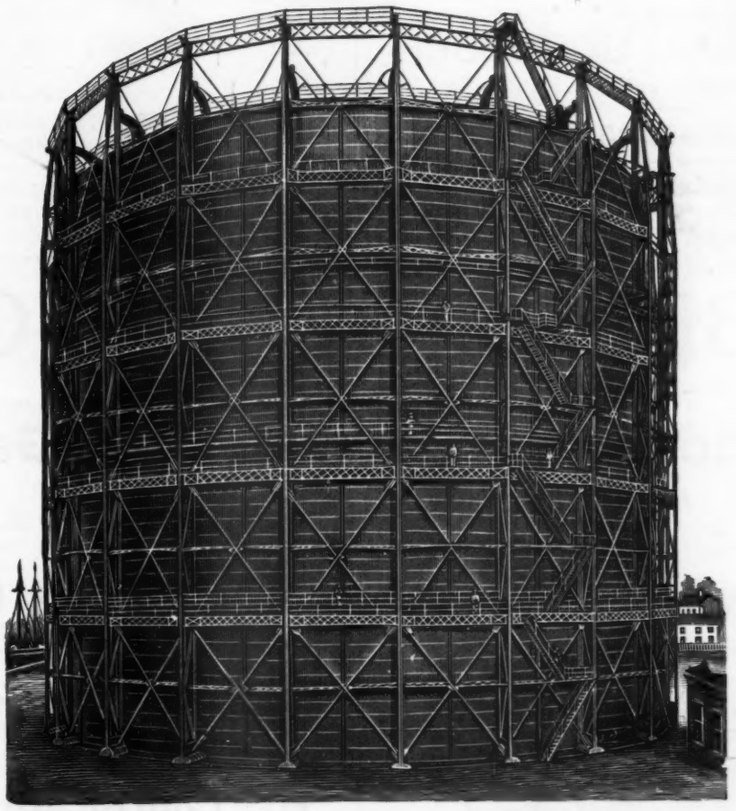

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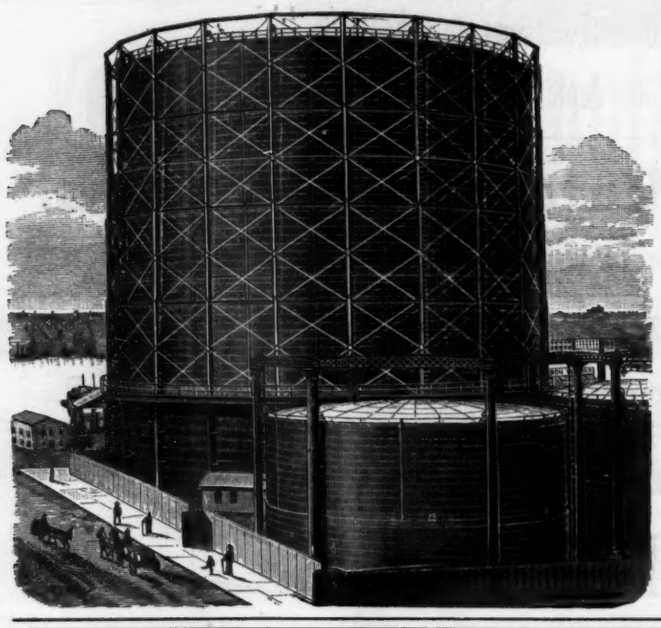

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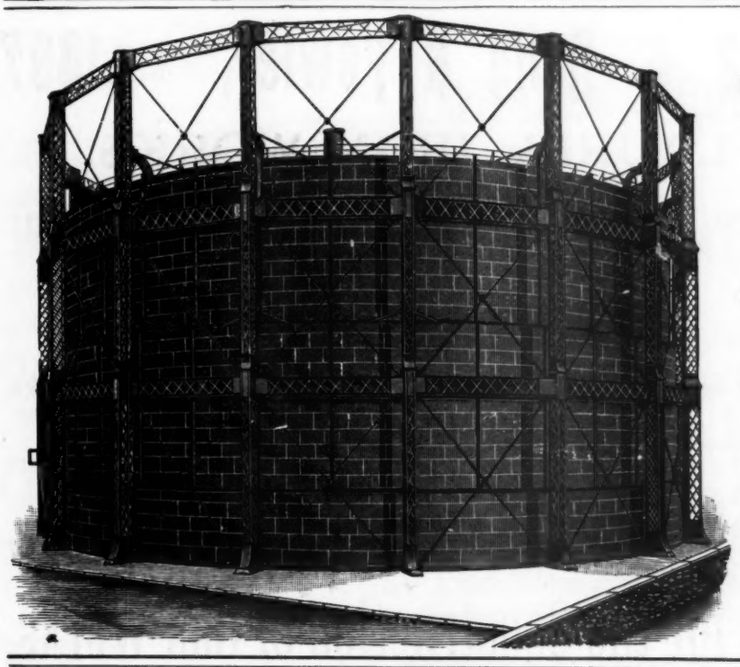

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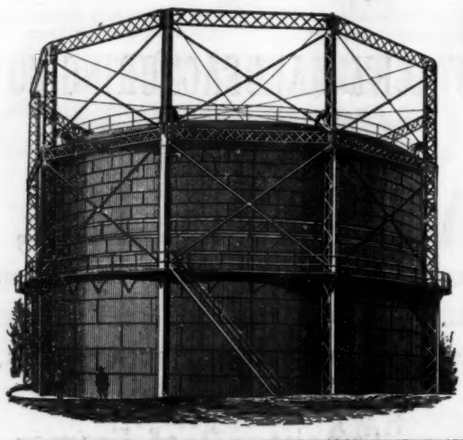

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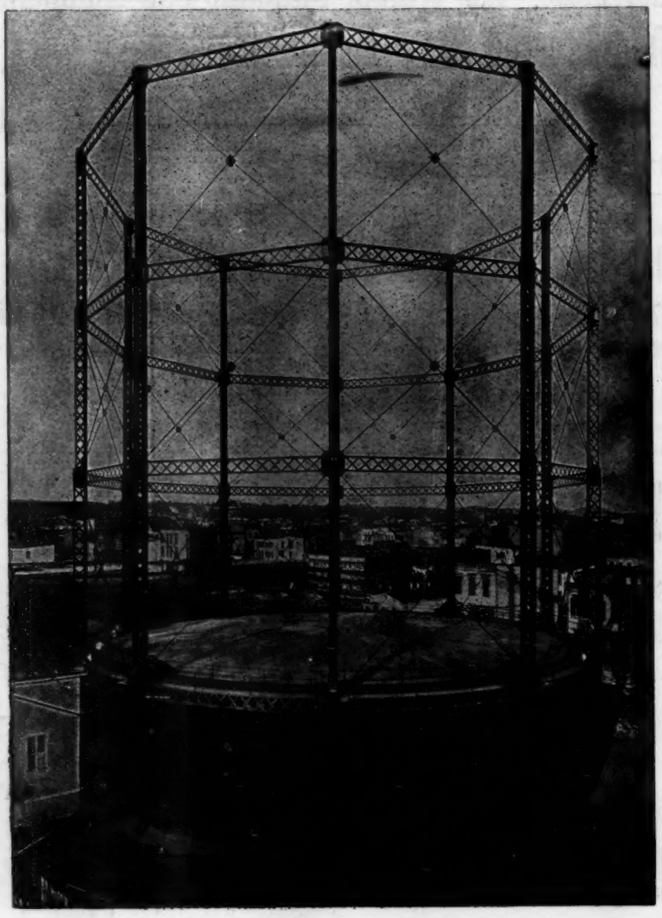

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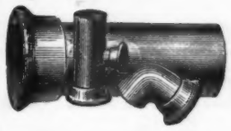

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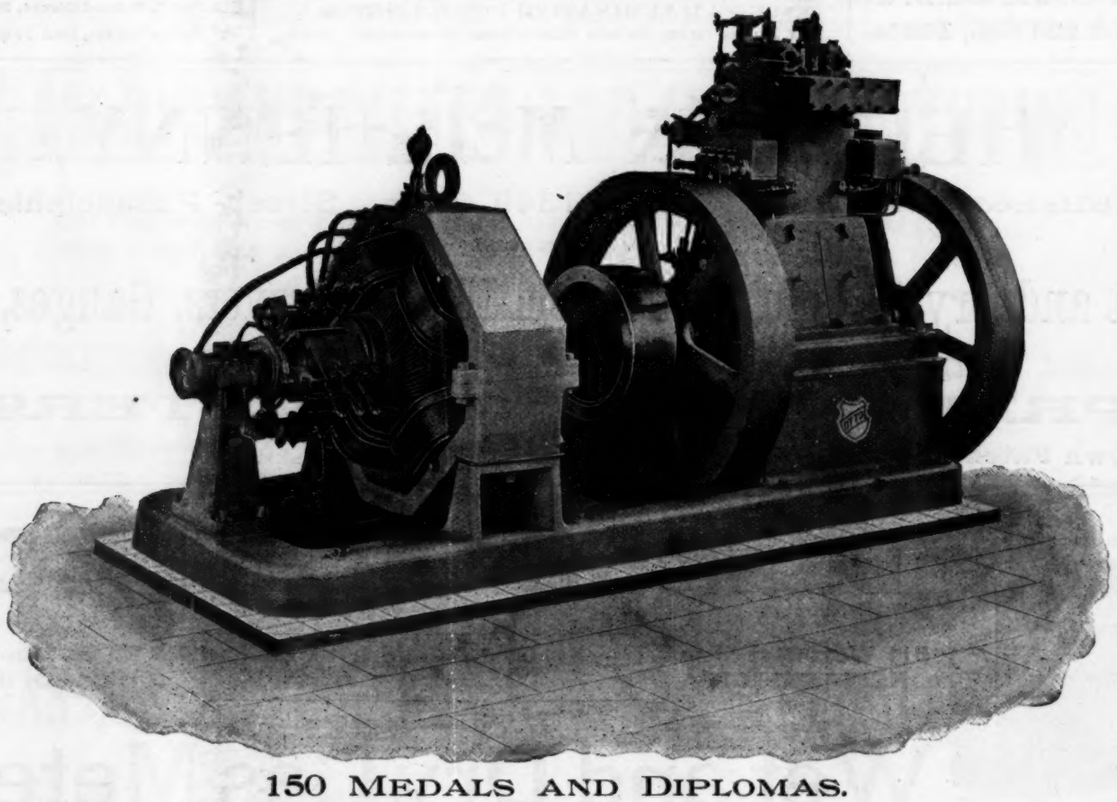

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